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MANNED MISSION HIGHLIGHTS

CHRONOLOGY OF 'SOYUZ T-4' MISSION

[Editorial Report] The Soviet News Agency TASS reports the following information on activities connected with the flight of "Soyuz T-4":

19 March

At 2114 hours Moscow time today the "Progress-12" transport ship was undocked from "Salyut-6"--"Soyuz T-4". Orbital parameters of "Salyut-6"--"Soyuz T-4" are now; apogee, 358 km; perigee,343 km; period, 91.4 min; inclination, 51.6 degrees. Today the cosmonauts performed repairs on the physical training complex and the "Malakhit" biological experiment unit. [Moscow TASS in English 2020 GMT 19 Mar 81]

21 March

"Progress-12" has been deorbited and disintegrated over the Pacific Ocean. Yesterday the cosmonauts repaired a television camera and began a series of biological experiments in the "Magnitogravistat" unit to study the effect of a non-homogeneous magnetic field on sprouts of higher plants. A medical examination of the cosmonauts was performed yesterday. The "Polinom-2M" unit was used to study the bioelectric activity of the heart. Today's program includes activation of scientific apparatus, cleaning of the station and physical exercises. In the evening the cosmanauts will talk to their families in a two-way TV hookup. [Moscow TASS in Russian 21 Mar 81]

22 March

At 1759 hours Moscow time the "Soyuz-39" spacecraft was launched with a crew consisting of Flight Commander Vladimir Dzhanibekov and Cosmonaut-Researcher Jugderdemidiyn Gurragchaa of the Mongolian People's Republic. The flight program includes docking with the "Salyut-6"--"Soyuz T-4" complex and performance of scientific and technical experiments with Cosmonauts Kovalenok and Savinykh. [Moscow TASS in English 1716 GMT 22 Mar 81]

23 March

At 1928 hours Moscow time on 23 March, "Soyuz-39" docked with the "Salyut-6"--"Soyuz T-4" complex and Cosmonauts Dzhanibekov and Gurragchaa transferred to the station. The program of scientific research, which was developed jointly by Soviet and Mongolian scientists, is scheduled to last seven days. All the cosmonauts are feeling well and have begun work on their joint experiments. [Moscow TASS in Russian 24 Mar 81]

24 March

The crew's work day began at 1100 hours Moscow time and will continue until 2300 hours. Cosmonauts Dzhanibekov and Gurragchaa will conduct several medical studies, including the "Bioritm" ("Biorhythm") experiment, to study adaptation to weightlessness. Cosmonauts Kovalenok and Savinykh will work on the experiments with higher plants and will also perform a number of visual observations as part of the program for study of the earth's resources and environment. In the second half of the day the "Soyuz T-4" crew will perform physical exercises while the "Soyuz-39" crew will be taking motion pictures. In the evening the cosmonauts will make a TV report on the medical and biological experiments being performed aboard "Salyut-6". [Moscow TASS in Russian 24 Mar 81]

25 March

During the "Soyuz-39" crew's second day aboard the station the major part of the day's program will be devoted to medical studies to determine features of the organism's adaptation to weightlessness. Dzhanibekov and Gurragchaa will perform the experiments "Bioritm" ("Biorhythm"), "Opros" ("Interrogation"), "Vospriyatiye" ("Perception") and "Vremya" ("Time") which are designed to study the cosmonauts' feelings and work capacity and to determine their subjective reactions to flight conditions. The experiment "Krovoobrashcheniye-Sprint" ("Blood Circulation - Sprint") will study the effect of redistribution of blood on the condition of the cardiovascular and respiratory systems in the initial stage of the flight. In this experiment a number of the cosmonauts' physiological parameters will be measured while they work on the veloergometer under measured loads. Kovalenok and Savinykh are assisting their comrades, monitoring the scientific equipment and taking motion pictures of the activities of the Soviet-Mongolian crew. Yesterday an experiment was begun to study primary cosmic radiation using an apparatus developed by Soviet and Mongolian scientists. The cosmonauts installed dielectric detectors in the work module and the airlock of the station. Upon completion of the experiment the receiver units will be returned to earth for studies of the recorded tracks of atomic nuclei and to determine their charge and energy. [Moscow TASS in Russian 25 Mar 81]

26 March

Cosmonauts Dzhanibekov and Gurragchaa are performing planned experiments while Kovalenok and Savinykh assist them and provide the required orientation of the station in space. Today's program includes further collection of data on adaptation to weightlessness by performance of the "Bioritm" ("Biorhythm"), "Rabotosposobnost'" ("Work Capacity") and "Neptun" ("Neptune") experiments. The "Neptun" experiment studies changes in the cosmonauts' visual acuity and depth perception during the flight. Using the "Spektr-15" spectrophotometer and the photo apparatus on the station, the crew performed the "Gorizont-Zarya" ("Horizon-Glow") and the "Illyuminator" ("Viewing Port") experiments. The

"Gorizont-Zarya" experiment identifies photo survey errors caused by the earth's atmosphere and determines the atmosphere's optical characteristics. The "Illyuminator" experiment involves a quantitative evaluation of changes in the optical characteristics of the station's viewing ports caused by long exposure to space. The cosmonauts also carried out a number of technical experiments using a visual polarization analyzer developed by Soviet and Mongolian scientists. These experiments will make it possible to increase the efficiency of earth resources studies from space. In the evening the cosmonauts had two TV press conferences for Soviet and foreign correspondents. The flight is proceeding normally and the cosmonauts are feeling well. [Moscow TASS in Russian 26 Mar 81]

27 March

During their fourth working day the cosmonauts performed the "Gologramma" ("Hologram") experiment to determine possibilities for using holograms in space for recording and transmitting images of objects. The cosmonauts performed two separate experiments using a protable helium-neon laser and recording units. Kovalenok and Savinykh made a holographic picture of one of the station viewing ports which had marks of micrometeorite impacts on its outer surface. Dzhanibekov and Gurragchaa recorded the process of a sodium chloride crystal dissolving in conditions of weightlessness. The films with the hologram images will be returned to earth for laboratory study. This evening for the first time their will be transmissions of holographic images from "Salyut-6" to earth and from earth to the station. Today's program also includes the joint Soviet-Mongolian experiment "Altay-1" to study processes of diffusion and mass transfer in a melt of lead and tin. Biological experiments are continuing. The cosmonauts are recording the development of peas and onions in the "Vazon" ("Flowerpot") and "Oazis" ("Oasis") units and are studying barley seeds in the "Biogravistat" unit. [Moscow TASS in Russian 27 Mar 81]

28 March

A large part of the fifth day aboard the station was devoted to geophysical studies. As the orbital path of the station passed over Mongolia, Cosmonauts Dzhanibekov and Gurragchaa made observations and photographs to study geological features, water resources and pasture conditions. Two joint Soviet-Mongolian experiments in materials science were performed. The "Erdenet" experiment studies processes of diffusion and redistribution of impurities during dissolution and crystallization of copper sulfate in water. The process was sequentially recorded on film. The "Altay-2" experiment studied growth of crystals of vanadium pentoxide in the "Splav" apparatus. Today Cosmonauts Kovalenok and Savinykh performed the technical experiment "Resonans" ("Resonance") to determine dynamic characteristics of the station. They also took samples of air and microflora in the station compartments. In the evening the cosmonauts will make a holographic image of one of the station's viewing ports. The "Izlucheniye" ("Radiation") experiment, which recorded particles of primary space radiation, has been completed. The cosmonauts have removed the dielectric detectors from the work module and airlock and have prepared them for return to earth. [Moscow TASS in Russian 28 Mar 81]

29 March

The cosmonauts are in the final stages of the program of joint Soviet-Mongolian experiments aboard the "Salyut-6"--"Soyuz T-4"--"Soyuz-39" orbital complex. Materials are being prepared for return to earth. Today Cosmonauts Dzhanibekov and Gurragchaa made visual observations and photographed the northwest and central regions of Mongolia to study geological features, evaluate pastures and observe areas with potential for mineral exploration. At the request of GDR specialists, observations and photography will be carried out of areas of the German Democratic Republic and the Baltic Sea in the interests of resources studies. The visiting crew is preparing "Soyuz-39" for descent from orbit. The life-support, orientation and control systems are being checked and the engine will be test fired. In the evening there will be a TV report on the conclusion of the joint operations aboard the station. The "Salyut-6" saation, which was placed in orbit on 29 September 1977, has been functioning for three and a half years. It has completed 20,140 revolutions around the earth. [Moscow TASS in Russian 29 Mar 81]

30 March

At 1442 hours Moscow time on 30 March the "Soyuz-39" crew returned to earth. Cosmonauts Dzhanibekov and Gurragchaa landed 170 kilometers southeast of Dzhezkazgan. Both felt well after the landing. Among the experiments they performed aboard the "Salyut-6" station were photography of areas of the earth and ocean surface, experiments on processes of diffusion and mass transfer, as well as production of new compounds in conditions of microgravity. An important part of the research program was devoted to development of new methods for recording and transmitting holographic images of objects for solution of various scientific and technological tasks in space. A large volume of medical and biological research was also performed. [Moscow TASS in Russian 31 Mar 81]

CSO: 1866/120-P

COSMONAUT RYUMIN IMPLIES 'SOYUZ T-4' FLIGHT WILL NOT EXCEED 3 TO 4 MONTHS

Moscow IZVESTIYA in Russian 28 Mar 81 p 3

[Report on press conference at Flight Control Center by B. Konovalov]

[Excerpt] Valeriy Ryumin, who spent 185 days in orbit together with Leonid Popov, was asked by reporters whether the present flight would last longer than his. He replied, "No, the present basic expedition will not be as long. After the first and second long-duration flights I said at a press conference that men could work in space for even longer periods. But, nevertheless, after three to four months of work in orbit, fatigue begins to build up. If there is no special need and no very important tasks to be performed, then there is no particular sense in subjecting the cosmonaut's organism to an endurance test."

CSO: 1866/116-P

PRE-FLIGHT PRESS CONFERENCE WITH 'SOYUZ T-4' CREW

[Editorial Report] Moscow PRAVDA in Russian on 13 March 1981, pages 1 and 3 reports that at a pre-launch press conference Cosmonaut Kovalenok stated that after his first flight on "Salyut-6" two years ago he had many meetings with specialists who use data transmitted from space. He expressed confidence that in the present flight he along with Savinykh, a specialist in optical instruments, would be able to provide more data of interest to specialists in oceanology, fisheries, geology, glaciology, agriculture and forestry. In response to a question as to how they envisage the future of space technology twenty years from now the "Soyuz T-4" cosmonauts replied that they see the main line of development as specialization of spacecraft for performance of specific tasks.

Moscow IZVESTIYA in Russian on 14 March 1981, pages 1 and 3 reports that Kovalenok's favorite occupation in his first flight on "Salyut-6" was visual observation of the ocean surface. After his return he spent much time with fisheries specialists discussing his observations and going over photos brought back from the mission. Viktor Savinykh's background includes work in the planning group for the 1975 flight of Cosmonauts Klimuk and Sevast'yanov. After his army service Savinykh studied in the optico-mechanical department of the Moscow Institute of Engineers of Geodesy, Aerial Photography and Cartography. After graduating in 1969 he worked in a design bureau specializing in optical instruments for space. He entered the cosmonaut corps in 1978 and by the end of 1980 he had completed training for flight on the "Soyuz T".

CSO: 1866/92-P

'SOYUZ T-4' RENDEZVOUS AND DOCKING WITH 'SALYUT-6'

[Editorial Report] Moscow PRAVDA in Russian on 14 March 1981, page 6 reports that Kovalenok's first reaction to flight in the "Soyuz T" was mixed: "In this ship it's more pleasant, but not easier; there's more work to do." Savinykh was reported to be reacting very well to his first space flight. Even in the first phase of the flight his pulse rate never exceeded 78 beats per minute. Moscow PRAVDA in Russian on 15 March 1981, page 6 states that the "Soyuz T-4" rendezvous and docking procedures are performed by a program in the memory of the onboard computer. In pre-launch statements the cosmonauts indicated that their role was basically one of monitoring of the instruments. At the Flight Control Center Cosmonaut Oleg Makarov commented that Savinykh was much more familiar with the "Soyuz T" ship than Kovalenok. Kovalenok had worked with the new modifications of the "Soyuz T" only in September of last year. However, Kovalenok was thoroughly familiar with the "Salyut-6" station from his previous flight experience. In Moscow IZVESTIYA in Russian on 15 March 1981, page 3 Makarov states that Savinykh was one of the first cosmonauts to work with the "Soyuz T" and that in the first phase of the flight Savinykh would have the leading role, whereas after transfer to "Salyut-6" Kovalenok would be in charge.

Tallinn SOVETSKAYA ESTONIYA in Russian on 15 March 1981, page 4 points out the success of the "Soyuz T-4" onboard computer. The computer determined that rendezvous with the "Salyut-6" should be delayed slightly so that docking would not occur too early and be outside the zone of radio visibility. As the "Soyuz T-4" prepared for docking, signals from the ship were received by the space support ship "Kosmonavt Georgiy Dobrovol'skiy" off the coast of Africa, then by "Kosmonavt Yuriy Gagarin" anchored in the Straits of Gibraltar, then by the ground station at Yevpatoriya. Docking occurred at 2333 hours over the Aral Sea.

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'YELENA' GAMMA TELESCOPE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 11, Nov 80 pp 44-45

[Article by Professor A. Gal'per: "The Gamma Telescope in the Space Laboratory"]

> [Text] "The cosmonauts performed the schedules series of measurements of gamma radiation flux in near-earth space using the miniature 'Yelena' gamma telescope and prepared the instrument for further experiments." (from a TASS communique)

As is well known, gamma radiation occurs primarily during various kinds of nuclear processes, when as a result of the collision of high energy particles (such particles are called cosmic rays) with interstellar gas, there is a strong excitation of the nuclei or even the generation of elementary particles. The excited nucleus, in arriving at the normal state, radiates a gamma quantum. In turn, the elementary particle can decay and likewise emit a gamma quantum of even higher energy. Gamma radiation also occurs during the motion of high energy electrons in magnetic fields in space, and during the annihilation (merging) of matter and antimatter. Thus, gamma radiation makes it possible to study the nuclear processes occurring in outer space. And it hardly needs to be proved why it is so important to record this.

However, there are a number of difficulties on the road to this research. The fact is that cosmic radiation is absorbed in the earth's atmosphere. It can be recorded only from a spacecraft or as a last resort, from a balloon at an altitude of 40 kilometers. An besides this, the gamma quanta fluxes are quite small and amount to hundredths and thousandths of a percent of the overall cosmic ray flux. For this reason, each gamma quantum must be recorded separately and its energy, direction and arrival time determined. Finally, a gamma quantum is a neutral particle. Consequently, it must first be converted to a charged particle, and then registered by means of devices, the operational principle of which is based on effects produced by electrical charges.

This is why research in the gamma range lags substantially behind research in X-ray band, where about a thousand space objects emitting X-rays have been ascertained at the present time. Candidates for "black holes" are also among them. Only the luminesence of our galaxy and 20 or so gamma stars have been detected in the gamma range, two of which were discovered by Soviet scientists.

The interests of astrophysicists require the development of various fields of astronomy outside the atmosphere, including gamma astronomy. Soviet scientists, along with French scientists, have set about the design of a highly sensitive gamma telescope. This project will be realized in the next five-year plan. But it is now already necessary to study the physical conditions under which this unique scientific gear is to operate. In this case, the issue is not that of such parameters as temperature, pressure, humidity, etc. (they have been well studied and can be programmed), but rather on the background gamma quanta and charged particle fluxes (primarily electrons). They occur in the orbital stations themselves with the interaction of the primary cosmic rays and the material of the structures, as well as the earth's atmosphere. By knowing the background fluxes (they are still called secondary fluxes), one can ascertain the cosmic gamma radiation against their background level.

The miniature "Yelena-F" gamma telescope was developed to solve this complex problem in the Moscow Engineering Physics Insitutte. V. Lyakhov and V. Ryumin have performed the first stage of measurements in the "Gamma-Fon" (Gamma background) experiment with it. The fourth main crew of the "Salyut-6", L. Popov and V. Ryumin, is continuing this work now.

The operational principle of the "Yelena-F" telescope consists in the following. A gamma quantum, in passing through the first scintillation detector (it does not respond to neutral particles), falls on a lead plate (the converter). Here it disappears, and an electron and positron appear in its place. Both charged particles fly in the same direction and are recorded sequentially in several scintillation counters (light flashes, scintillations, appear in them when exposed to ionizing radiations). Lead plates are placed between the fourth and fifth counters, which are good absorbers of electrons and positrons. Depending on the energy of the gamma quantum, the electron and positron either pass through these plates or get stuck in them. There is a gas Cerenkov counter in the telescope to register the particles traveling only from the top down.

The entire process of converting a gamma quantum to an electron-positron pair and its subsequent passage through the instrument takes no more than one nanosecond (10^{-9} sec). Then for about 50 nanoseconds the electronic circuitry of the telescope analyzes the signals from the various counters and feeds out the information on the fact of a gamma quantum passage and its energy to the recording system. The central recording section of the telescope is surrounded by additional scintillation counters, which make it possible to reduce the contribution to the recorded gamma quanta flux of the various imitative processes.

Since all of the counters operate continuously, the instrument can also register particles simultaneously with the gamma quanta. Up to 20 various combinations (channels) of signals from the counters are realized in the telescope, something which provides a rather complete picture of the fluxes of gamma quanta, electrons (in the same energy bands as the gamma quanta) and protons having an energy of several hundreds of millions of electron-volts. The large number of various combinations makes it possible to duplicate and increase the operational reliability of the instrument.

The telescope has an independent data recording unit consisting of two tape transport mechanisms and a system of photodiodes which record the readings of all 20 channels on the moving photographic film as well as the auxiliary data such as the time, power supply voltage, etc.

On the front panel of the instrument is located the control panel on which a series of display elements are situated, as well as the telescope operational mode switches for the analysis of a nonstandard situation and a single power supply plug which connects the telescope to the on-boar systems of the station.

The general characteristics of the telescope are: the area of the input window is 50 cm^2, the angle of view (aperture) is 30°, the range of energies which can be effectively registered is 30 to 500 MeV, the power consumption is 10 watts, the weight is 20 kg and the dimensions are 300 x 300 x 500 mm. The telescope can operate continuously up to 20 hours, depending upon the stock of film in the recorder

All of the measurements of the first stage of the experiment can be broken down into three series. First of all, the measurement of the background gamma quanta fluxes in various parts of the orbital station complex. Secondly, the measurement of gamma quanta and electron fluxes coming from the earth. And finally, the measurement of the electron fluxes existing in the immediate area of space. An unprogrammed experiment, but one which is interesting from a technical viewpoint, was the simultaneous measurement of the gamma quanta and electron fluxes in the orbital station complex and in a high altitude balloon using two "Yelena-F" telescopes.

The execution of the program started the moment the "Yelena-F" telescope was delivered by the "Progress-5" transport ship and continued in individual sessions of 5 to 10 hours each practically up to the last working day of cosmonauts V. Lyakhov and V. Ryumin. The overall aggregate of measurements ran for 110 hours. The telescope was successively installed in the "Progress", in the "Salyut-6" and in the "Soyuz-32". Fluxes from the earth and in near space were measured in the "Soyuz-32", where the instrument was placed flush against the thinnest wall of the ship.

We will note that such a large number of measurements in various positions and at various times became possible only with the active participation of the cosmonauts. The role of the crew did not reduce just to setting up, turning on and reloading the film. The cosmonauts also performed complex repair and preventive maintenance work.

It was determined as a result of the first stage of the experiment that the secondary gamma quanta fluxes differ substantially in different compartments of the space laboratory. They are maximal from the equipment compartment and minimal close to the thin walls. A preliminary estimate was obtained for these fluxes. It turned out that while they are insignificant from the the viewpoint of crew safety, they can be too high for precision measurements. And this means that it is essential to install the equipment in a definite manner and take special measures to shield against the background.

The background fluxes depend substantially on the geographic latitude at which the measurements are made. They are least at the equator and increase by almost a factor of 10 at the higher latitudes. The weakest dependence is due to the orientation of the station in space. This important result makes it possible to extend the observation time in the upcoming experiment.

The gamma quanta and electron fluxes from the earth (albedo) were measured in four sessions. Measurements were made of charged particle fluxes (primarily high energy electrons) in the region of the Brazilian anomaly, where protuberances of the radiation belt descend down to the flight altitudes of the station. Relative increases in the count were observed when crossing the region of the Brazilian anomaly against the background of the usual intensity oscillations relating to the travel of the satellite from the equator to the high latitudes and back. All of these measurements are of interest to the scientists studying near-earth space.

The detailed processing of the experimental material obtained by Soviet cosmonauts is continuing. But the overall physical picture of the conditions in the station has already been obtained. However, as is frequently the case in scientific research, new questions come up in place of the one resolved question. It has become necessary to not just continue the "gamma background" experiment, but to also expand the program.

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'ISPARITEL'' EXPERIMENT ON 'SALYUT-6'

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 80 pp 44-45

[Article by engineer A. Kalinin: "The 'Vaporizer' Works"]

[Text] Repair and restorative work on-board orbital stations is not only an effective means of improving the operability of their systems, but is also a requisite condition for long term, economically justified missions. The repair and restoration of orbital stations during a mission belongs to the field of space technology: a new area of scientific knowledge.

More than 200 technological experiments have been performed in the orbital "Salyut-6"-"Soyuz" complex. Among them is the deposition of metal coatings on various surfaces. The role of all possible kinds of coatings in providing for certain thermal conditions and protecting spacecraft against ionizing radiations is extremely important. Restoring them during long missions is becoming an increasingly urgent problem.

As is well known, an important system of the "Salyut-6" station is the thermal control system. Special coatings applied on the outside of the vehicle, in conjunction with the active facilities of this system, despite the enormous temperature gradient on the outside (on the sunside it is+150 °C, and on the shaded side, -150 °C) maintain a specified temperature on the inside.

With longterm exposure of the thin thermal regulating coatings to the deep vacuum, the large temperature gradient, solar radiation, cosmic radiation and micrometeorites, the coatings age and lose their initial optical properties. As a result, the thermal regulation system no longer radiates and does not receive the design amount of thermal energy from the sun, and the temperature mode in the station is gradually disrupted. The continuation of the mission becomes possible only if the optical characteristics of the thermal regulating coatings are restored.

The associates of the Electrical Welding Institute imeni Ye.O. Paton of the Ukrainian Academy of Sciences designed an installation for working on-board the "Salyut-6" station for the purposes of applying thin metal coatings (vapor deposition) under conditions of microgravitation and a vacuum. It operates in the following manner. The electrons emitted by an electron gun, placed in a vacuum, bombard the molten metal which is located in a refractory crucible. The metal is intensively vaporized and precipitated on a plate. The window through which the metal vapors fall on the plate is opened and closed by a blind on the command of the operator. The thickness of the deposited metal layer is regulated in this fashion. It is proportional to the time between the opening and closing of the window.

Everything is rather simple at first glance. In fact though, this is an extremely complex technical problem, which was solved in space for the first time. V. Lyakhov and V. Ryumin started this direction of experimental work on board the "Salyut-6" orbital station, and it was then successfully continued by L. Popov and V. Ryumin.

The performance of the experiment in the "Salyut-6" stations was preceded by the theoretical training of the crew, practical exercises and training exercises on specialized trainers using a teaching and training model of the "Isparitel'" ["Vaporizer"] installation, which was an analog of the present installation. It stands to reason that it is impossible to demonstrate the deposition process in it, since a deep vacuum is necessary for this, the creation of which under the conditions of the "Salyut-6" station trainer at the training center was difficult.

The training of the crews was governed by a program which included a course of lectures on the individual areas of space technology and materials science, lectures and practical exercises on the structural design of the "Vaporizer", the installation and removal of the unit in the station, as well as the working out of a procedure for the performance of the experiment and a detailed study of the special features of its operation when creating the vacuum in the air lock.

Experiments on growing crystals of semiconductor materials and alloys, optical glasses, composite and other materials in the "Kristall" ["crystal"] and "Splav" ["alloy"] production process installations were widely represented in the research programs of the last crews of the "Salyut-6" station. The results of these experiments were to comprise the basis of the technology for future industrial production in space.

The working processes in the "alloy" and "crystal" installations were automated. The obligations of the cosmonauts-researchers amounted only to the installing of the capsules with the original materials, setting the experimental programs and turning on the installations and periodically checking their operation. The experiments with the "Vaporizer" required considerable labor. No automatic execution of the program was provided in it.

The "Vaporizer" consists of the working unit with two electron guns and a manipulator for changing the deposited plates which are electrically connected to the remote control panel. A deep vacuum is needed to perform the experiment, and for this reason the cosmonauts mount the working unit of the "Vaporizer" in the air lock of the "Salyut-6" station, depressurite it and open the outer hatch of the lock. In this way the working unit is in the space outside the vehicle. The requisite commands are fed from the control panel.

Two persons took part in the experiment. One monitored the readouts and signaling and gave the requisite instructions from the control panel while the other kept a precise time count of the vacuum deposition using a stopwatch. Each plate had its own exposure time. They were coated on both sides.

In training for these experiments, special attention was devoted to working with the air lock. And not surprisingly: a loss of the lock seal, damage to its assemblies during the experiment, the installation or removal of the working unit of the "Vaporizer" could have serious consequences.

The moment the unit was turned on during the flight of V. Lyakhov and V. Ryumin was awaited with excitement by its designers, the creators of the experiment and specialists who participated in the training of the crew.

The first time the "Vaporizer" was turned on and given a test check in space, it unexpectedly turned out that the installation aligned under laboratory conditions required additional extremely precise adjustments. The crew did not come up against this operation in the preflight ground training exercises. This caused certain complications. But after recommendations were forwarded from the flight control center, the cosmonauts managed to deal with the difficulties and soon Valeriy Ryumin reported that the "Vaporizer" had begun to work. The operation subsequently went in accordance with the procedure which had been worked out.

Even before the crew returned to earth, scientists received 24 samples of vaporization coated plates. A check of their quality in laboratories yielded excellent results. The analysis of the coatings of several samples showed that the film does not lose its mirror nature at thicknesses greater than the designed value. And this means that in weightlessness, one can obtain a stronger mirror coating than under ground conditions. However, such a hypothesis was still in need of a test. For this reason, the next main crew composed of Leonid Popov and Valeriy Ryumin enthusiastically took up the work for the purpose of making deeper and more universal studies.

The crew training program included the same sections as that of the previous expedition. In this case, a video film was used to record the actions of the operators during the performance of the "Vaporizer" experiment, including the performance of the preparatory and final operations. Moreover, pratical assignments were provided to change the crucibles with the metals in the working unit of the "Vaporizer", as well as preventive maintenance and the adjustment of the electron guns. Such operations are assigned to highly skilled specialists in plants and institutes. Naturally, the scientists had doubts: could the cosmonauts handle such precise work? V. Ryumin and L. Popov disassembled the electron guns twice, replaced parts in them, and made the adjustments and alignment. The results exceeded all expectations!

The cosmonauts performed two cycles of studies and after the final series of experiments, removed the "Vaporizer" from the air lock, and installed the "alloy" electrical furnace in its place.

The cosmonauts did excellent work in orbit; now it is up to the scientists. The development and fabrication of more sophisticated devices will depend on the results of the research which has been done. In the future, when the installation, repair and restoration work are expanded in open space, the "Vaporizer" type installations, both automatic and manual, will find widescale application.

The first steps in space technology have already been taken. The study of the specific features of the course of technological processes during orbital space flight is continuing. The collection box of knowledge is being filled with every new experiment formed by the cosmonauts. The time will come when industrial facilities will start operation in near-earth orbits, people will erect unusual unearthly structures there so as to more fully utilize the unique conditions of outer space in the interests of science and the national economy.

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LEONOV ON EXTRAVEHICULAR ACTIVITY

Moscow SOVIET MILITARY REVIEW in English No 3, Mar 80 pp 14-17

[Interview with Maj Gen Avn Aleksey Leonov by correspondent I. Barchukov: "Man in Open Space"]

> [Text] On March 18, 1965, during the flight of the "Voskhod-2" spaceship Pilot Cosmonaut Lieutenant-Colonel Aleksey Leonov, wearing a special space suit with a self-contained life-support system emerged into open space for the first time in the world.
>
> Having successfully fulfilled the programme of experiments and observations, he returned safely to the spaceship.
>
> Subsequently other cosmonauts also walked out into space to carry out various assignments.
>
> I. Barchukov, "Soviet Military Review" correspondent, asked A. Leonov, now Major-General of the Air Force, the following questions.

[Question] Exit into open space entails great difficulties, doesn't it? Would you kindly tell our readers about the most typical of them and what is done to overcome them?

[Answer] Emergence into open space has become of exceptional importance, although the procedure itself remains complicated. When a man leaves the spaceship, he finds himself in a vacuum with sharp temperature fluctuations and unusual illumination.

Further progress is now inconceivable without exit into open space. This process is still being developed, each exit being a step into the future.

During the last 15 years many Soviet cosmonauts and American astronauts have taken space walks, the last one being by V. Lyakhov and V. Ryumin who worked in open space for one hour and twenty-three minutes. During that time they dismantled the scientific equipment installed on the ship's hull, and deflected the radiotelescope antenna from the station. Although this operation had not been planned in advance, the cosmonauts displayed assurance, self-possession and courage.

On leaving the spacecraft the cosmonauts experience what is called "spacephobia," because they find themselves face to face with the infinity. Cosmonauts must also possess correct perception of the spatial position of objects beyond the Earth's limits; otherwise their normal functioning and safety become impossible. Each exit into space is another step on the road of studying spatial perception, the means of correct orientation, and methods of activity outside the ship.

That is why my comrades and I went through a whole training complex, including special physical exercises, parachute jumping and jet aircraft flights, and also work in a flying laboratory where the cosmonauts experienced short-time weightlessness. In these conditions they had to work up the sequence of steps to be taken in order to emerge into open space and take decisions in special cases.

As a result of constant training, I did not experience a "psychological barrier" when I walked out of the spaceship. The very moment of leaving it did not cause the sharp emotional outburst that might have been expected. The same is true of the crews which emerged into space to service the orbital complex.

[Question] I believe that the role of the cosmonauts' physical and psychological training is constantly growing. What is your opinion about that?

[Answer] Yes, it is. To be able to leave the spacecraft without fear, a cosmonaut must be well-trained physically, display good vestibular and psychological stability, and visual and motor coordination. This is achieved through constant training on the ground and by physical exercises in the spacecraft itself.

As to myself, for example, from April 1964 to March 1965 I cycled over 1,000 km, covered nearly 300 km skiing and ran more than 300 km.

[Question] Will you please tell us how the cosmonauts orient themselves in space?

[Answer] While performing different motions, the cosmonauts orient themselves relative to the moving spaceship and the "stationary" Sun, which must be either overhead or behind. In the process of ground training and during flights in laboratory aircraft representing models of spaceships one develops a psychological feeling that the ship is the "bottom." This feeling persists when the cosmonaut leaves the spacecraft.

The stars, the Sun and the Earth may also serve as reference points. I found the halyard, provided it was well tightened, to be most useful for the purpose. These methods of orientation enabled me to carry out all the missions assigned.

Psychologists have discovered that switching over from spatial perception on the Earth to that in open space is still a difficult task, as the only source of information on one's position in outer space is the visual analyser.

This leads to a certain re-adaptation of the central nervous system, so that outside the spaceship man begins to develop new concepts, a new "subjective model" of the coordinates, because human sensations, including even those connected with touching separate items or support surfaces, change radically under these conditions. During my space flight I made the following observation regarding stereoscopic perception of space. When you look at the night sky from the Earth, the stars seem to be at equal distances from you. In outer space bright stars seem closer to you, and less bright ones, farther away. This illusion, however, does not hamper space orientation.

A cosmonaut experiences a feeling of free swimming, because the body is weightless, volume is not perceived and sounds are difficult to discern. It is probable that new forms of space orientation will be developed in the future, most likely in performing assembly or other operations on orbital stations.

Future cosmonauts will undoubtedly have new reference points and self-contained propellers which will enable them to move through space freely.

[Question] Will you please describe the space suit protecting the cosmonaut against the adverse effects of outer space?

[Answer] Work in outer space requires a comfortable and reliable space suit with a life-support system of a closed regenerative type, and also various facilities for movement, orientation, fixing oneself to one's workplace, and other special tools and instruments. Quite a few devices and accessories for use in outer space have already been developed. Some were tested on the "Salyut-6" orbital station.

The present-day space suit substantially differs from the 1965 model. For the first time in world practice the body and helmet make up a single metal cuirass, while the sleeves and trouser legs are made elastic. Whereas the suit I wore had to be laced up, this one is simple and quick to get into.

The space suit contains practically all the life-support units, just like the spaceship itself. For greater reliability, all systems and units have been duplicated. When wearing such suits the cosmonauts have highly appreciated their performance characteristics.

In the future, with large spaceships orbiting the Earth, whole groups of cosmonauts will be able to leave the craft simultaneously. When performing prolonged work in outer space they will need improved space suits for protection against low temperatures, radiation and meteorites. Presumably, the space suit will ensure greater freedom of movement, allow multiple operations to be performed, and provide a wider field of view for the cosmonaut.

[Question] You have painted numerous pictures showing the cosmonaut as a labourer of the Universe. Do you regard that as mere fancy or a thing of the near future?

[Answer] From a near-earth orbit the Universe appears in all its indescribable beauty. The Earth looks like a huge coloured map. During one orbit lasting 90 minutes I was able to watch not only day succeeding night, but also see all the seasons of the year. These impressions provide themes for my artistic work.

[Question] My last question: Will cosmonauts have to leave the spaceship in the future?

[Answer] The cosmonaut must necessarily know how to leave the ship. This skill must be constantly practised, of course. S. P. Korolev used to say that when flying through the Universe, one must be able to emerge into open space, just as when sailing on an ocean liner one must not fear falling overboard and for that one must learn to swim.

During a space flight a station or ship may develop trouble or meet with an accident. To repair the craft or rescue the crew, the cosmonauts must be able to emerge into open space and perform the necessary operations.

In the future cosmonauts will have to leave the spacecraft to unload, assemble and service orbital stations, and carry out scientific and technical experiments.

Orbital stations will subsequently serve as launching pads for spaceships to fly to other planets. They will make refuelling of ships possible and provide conditions for the crews' rest and training. This will require space fitters, welders and other specialists capable of working in unusual conditions.

Conquering the near-earth space will enable mankind to make a great stride ahead on the way to solving numerous terrestrial problems. Future space flights, building manned orbital stations and exploring the Universe are inseparably linked up with man's activity in open space. There is no end of work in this field.

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RESULTS OF SOVIET-HUNGARIAN SPACE RESEARCH

Budapest NEPSZABADSAG in Hungarian 27, 28, 29 Jan 81

[Articles by Pal Gabor Peto]

[27 Jan 81 p 6: "How Did the Pille Score?"]

[Text] One of the great events of the last year, at least from a Hungarian viewpoint, was the participation of the first Hungarian astronaut, Bertalan Farkas, in the Intercosmos program. Although such a task undeniably requires diligence, initiative and a great deal of courage, the flight of Bertalan Farkas was basically scientific work. His title of research astronaut on board of Soyuz-36 and Salyut-6 was more than a mere formality.

There have been "Hungarians" on board of Soviet research rockets, spaceships and space stations before Bertalan Farkas: Hungarian experts designed and produced a number of instruments and also took part in the processing of data collected in space. There have been such instruments on the flight with Bertalan Farkas (not to mention his memorable meals, whose preparation was no mean scientific achievement).

Evaluation of the scientific results obtained in the course of last year's Soviet-Hungarian space experiment is still in progress. The job is quite enormous (there is a great quantity of data), requiring a great deal of care because a wrong move may destroy the result of an experiment that is perhaps unrepeatable. Other experiments will be repeated or continued, just as some of the investigations carried out by Bertalan Farkas were repetitions or continuations of earlier ones; thus, no data has been published regarding these. Some of them, however, can now be discussed.

When the radiation dosimeter developed and produced by the Central Physics Research Institute, named "Pille", was delivered to Soviet specialists before the joint space flight, they insisted on making a note of their appreciation in the record, while emphasizing the uniqueness of the instrument. This was not just politeness: the "Pille", whose weight is less than one kilogram, is indeed an excellent product that its creators can be proud of; and the nation may be proud of them.

Astronauts are exposed to harmful ionizing radiation exceeding earth surface levels even in the relatively low atmospheric layer where the spaceship travels, below the high-radiation Van Allen belt. In addition, one must expect strong bursts of radiation due, for example, to solar eruptions. For this reason, precise dosimetry within spaceships is very important. But more than precision alone is required: the instrument cannot take up a dreat deal of space within the spaceship where everything needed for such a fixed group of tasks must fit in. Weight is another factor that must be considered.

The Pille made by KFKI [Central Physics Research Institute] has fulfilled all of these requirements on a high level. As we said before, it weighs less than a kilogram and requires a power supply of only 3 to 4 watts. Its operation is simple: the little detectors, shaped like a pencil with an end that is similar to a key, located on the astronauts' body and various locations within the spaceship, are inserted into a receptacle on the "Pille". A light comes on indicating that the instrument is ready for measurement. The detector is then turned using the key-shaped handle; another light comes on indicating measurement in progress. In just one minute, the face of the Pille will display red numbers with a height of 7 millimeters, indicating the radiation dose detected by the dosimeter since the last readout. Each readout will rezero the instrument, i.e., it will be returned to the initial state. For reasons of power conservation, the numbers will go out in 5 seconds. Pressing another button will cause the numbers to be displayed again. The data is preserved within the Pille until the next readout.

Sixteen Detectors

How did the Pille pass the test on board of Salyut-6?

During his stay on the space station, Bertalan Farkas measured radiation doses detected by the dosimeters twice: on 28 May and on 2 June. On both occasions he had to record data from 14 dosimeters, since all four astronauts had dosimeters attatched to their suits, 8 more were placed in various locations within the space station and, finally, there were 4 more detectors placed there for control purposes, 2 of which were read on each occasion. These 4 detectors differed from the other 12 in that they were irradiated on Earth before the flight, using a rather large dose: they received 870 millirads or, to use current SI units, 8.7 mGy (milligray).

It must be mentioned that evaluation of the data obtained is not a very simple task: the individual sensitivity of each detector must be taken into consideration (resulting in a small deviation of data), together with the fact that prior to the flight the dosimeters also recorded the so-called natural background radiation here on earth.

Under the Allowed Limit

Researchers are still debating the size of the smallest radiation dose that is capable of causing damage to a human body. For practical purposes, they settled on an allowed radiation dose of 5 rad/year (or, using current units, 0.05 Gy/year). In terms of daily doses, this is equivalent to 14 millirads/day or 0.14 mGy/day.

Measurements show that the astronauts were exposed to daily radiation doses far below the allowed radiation levels which were set very conservatively. Doses were between 6.3 mrad and 10.9 mrad. Thus, the health of the astronauts was not in danger. (It is interesting, say the experts, that doses measured in 1980, at least during the flight in which Bertalan Farkas was a participant, were lower than those measured during the several months of the 1979 space flight using a different type of dosimeter.

The measurement results of calibration detectors provided an important and very good result. The discrepancy between expected and measured values was very small. The small size of the discrepancy in terms of percentages prove that the personal dose measurements carried out in space were precise and reliable.

In fact, the experts were supposed to receive this data only after the landing but, as we found out from their representative who was present in the control center during the space flight, Bertalan Farkas communicated these data from the spaceship, thus "overfulfilling the plan". By the way, our astronaut has recently visited KFKI where he talked with the designers of the Pille and had high praise for this convenient, clever and easy-to-operate instrument.

Although, strictly speaking, this is not part of our subject, our readers will probably be interested in two aspects of the future of the Pille. One is that the indicator of the 4 instruments already completed at the request of Soviet specialists to be used in the next space flight contains a decimal point, i.e., the precision of the readout will be improved by an order of magnitude.

Forward - to Day-to-Day Applications

Another fact of interest: the KFKI also produced a variant of the Pille capable of working off a 12 volt power supply, e.g., a car battery. This is intended to be carried by car in the vicinity of the nuclear power plant for instant evaluation of radiation doses detected by the dosimeters and filtering out background radiation doses with a distorting effect of data. In this way, space research is related to the solution of scientific and health protection tasks here on earth: this is one of the revealing aspects of this great enterprise.

[28 Jan 81 p 6: 2. "16,000 Photographs"]

During the joint Soviet-Hungarian space flight NEPSZABADSAG published an article titled "Photo Cosmos" which, according to its subtitle, discussed the subjects photographed by our astronaut and the purpose of such photographs. Bertalan Farkas has photographed many things: he photographed pre-defined areas in accordance with meteorological conditions but he was unable to take pictures of Hungary using his MKF-6 camera made in the GDR (capable of photographing in 6 separate frequency bands or "colors"). When the Salyut-6 spaceship flew over our country it was late afternoon and the amount of light was insufficient for photography. When the spaceship was in this region during lighter periods, our country was just on the horizon.

Natural Resource Exploration

Nevertheless, the pictures made in the course of the joint space flight are very valuable to Hungarian experts. The same is true for the ones made by Bertalan

Farkas: they are related to earlier space photos and are useful in formulating a remote sensing method that is still largely in an experimental stage. For example, a comparison of pictures of river estuaries with earlier space photos of the same regions reveals some changes. In addition, the photos and observations made by Bertalan Farkas make it possible for Hungarian specialists to ask more precise questions of the astronauts taking part in future space flights.

In addition, very valuable photographs were made in the course of other spaceflights besides the one on board of the Salyut-6 last May; this underlines the fact, frequently ignored by many, that the official term "joint space experiment" is used in place of "joint space flight" for a good reason. There have been other joint experiments concurrent with the activities of Bertalan Farkas.

One of the most important projects involved aerial photography aimed at natural resource exploration combined with space photos of Hungary made in 1979 by one of the "permanent" crews of the Salyut-6, Lyakhov and Ryumin as well as the pictures made by the crew of a Soviet flying laboratory visiting here at the time of Bertalan Farkas's space flight with the assistance of Hungarian specialists.

The expression "natural resource" is used today in an extended sense. According to a definition formulated by the UN, it includes all facets of nature used by a given society for its own purposes on a given level of development: clean water, mineral resources, plants, biomass, solar radiation, etc. Photographs made originally for purposes of cartography have also been used for natural resource exploration. It is hardly necessary to point out that a photograph made from a height of several thousand meters may be used to survey a much larger area than one made on the surface or from the top of a hill. Aerial photographs were used not only for topographic maps but also for making economic, soil, water resources, etc. maps, collectively called thematic maps by specialists. This method is raised to a higher level by observation and photography from space. But establishing a connection between photographs made from various elevations, which is indispensable for the interpretation of photographs, is a complicated problem. Last year's space flight included some joint work in this direction.

The Flying Laboratory and Others

In accordance with agreements, the "flying laboratory" of the Soviet Academy of Sciences installed on board of an AN-30 airplane visited our country last May. This aircraft takes photographs at a height of 6,000 to 7,000 meters using an MKF-6 camera and a multi-band sensor. Simultaneously, Hungarian specialists took photographs from a height of approximately 2,000 meters using AN-2 aircraft. Last but not least, measurements were taken at surface level. This "multi-story" experiment, combined with the Salyut photos of the preceding year, will be suitable for formulating and refining the methodology of natural resource exploration. At the same time, these photographs also serve a practical purpose.

The surface level measurements were made using spectrophotometers made in Bulgaria or obtained from the Baku Natural Resource Exploration Institute of the Azerbaijan Academy of Sciences. The former is an instrument mounted on a tripod transported from one site to the next and used for measuring the light reflection properties of the soil and plant cover in various regions of the spectrum. The instrument from Baku, called Kaspii, is suspended from a mobile crane during measurement.

By putting together the measurements obtained at each of the four levels (Salyut-6, AN-30, AN-2, surface), it is possible to draw precise conclusions regarding the status, ripeness and possible diseases of crops, purity of water, etc.

As we said last year, three areas of Hungary, each with different characteristics, were picked for this purpose: the Lake Balaton region, the portion of the Tisza-2 dam complex between Szolnok and Kiskore and the region surrounding the village of Penc where the Cosmic Geodedesic Observatory is located. On this occasion we will present a few photos from the Lake Balaton project, courtesy of the MTA [Hungarian Academy of Sciences] Intercosmos Council, the organization responsible for coordinating the work of the many participants. (We are grateful to Peter Szilagyi, main department head of the MEM [Ministry of Agriculture and Food Industry] National Geodesic and Cartographic Office for the technical information.)

For Example, Lake Balaton ...

The photo made by Salyut-6 was 185x185 millimeters showing an area of 36,000 square kilometers, i.e., more than one third of the area of Hungary (in our case, West of the Danube up to the Western border). Our Figure 1, showing part of Lake Balaton and the Tihany peninsula, was enlarged from this photo (the enlargement was fivefold, but it is possible to enlarge this picture by another factor of 20).

The next figure shows the same area; it is one of the six photos made by the six MKF-6 cameras on board of the AN-30; more precisely, it is an enlargement of part of one of these 6x9 cm photographs. Part of the Inner Lake is clearly visible in the upper left corner of Figure 2. In the upper middle part one can see Tihany with part of the road leading out of it; a forest is visible south of the parking lot (downward on the picture). On Figure 3, made in the infrared range, it is possible to distinguish between leafy and coniferous wood.

Differences in picture tone give an indication of the differences between different wavelengths. For example, Lake Balaton is completely dark in Fig. 3 because water does not reflect light in this frequency band.

This series, combined with the measurements from the AN-2 aircraft and those made at surface level (not shown here) is suitable for checking water purity in Lake Balaton, distinguishing types of soils and plants (e.g., trees) as well as achieving further refinements in our method of interpretation.

An interesting discovery in basic science has been made with the help of pictures provided by Salyut-6. Geologists assumed for quite a while the existence of an enormous crack under the surface starting from Zagreb, crossing the Dunantul in a SW-NE direction all the way to Klyuch (in Siberia). This fault is visible on the photos made from Salyut-6, and only on these photos (presumably due to a fortunate coincidence of microclimatic, atmospheric and humidity conditions). In contrast to previous assumptions, the fault does not pass through the Southern part of Csepel Island; instead, it goes through Dunaharaszti, which means that it may be related to the January, 1956 earthquake. The photos also show the existence of a "bend" in the fault: from Dunaharaszti it makes a wide turn toward the Mecsek mountains, then it turns north to Lake Balaton, before continuing toward the southwest.

Many more interesting things could be said about these photos. Various sectors of the national economy could obtain a lot of interesting information from the 16,000 photos made over the same areas in 1979 and 1980. This requires instrumentation (not too expensive, and often quite simple instruments) and especially people who are receptive and supportive of new ideas as opposed to "well-tried methods", and are willing to take on the job of learning new techniques to discover heretofore unknown phenomena. According to specialists intimately familiar with the situation, there is much less enthusiasm in these areas now than at the time of Bertalan Farkas' space flight.

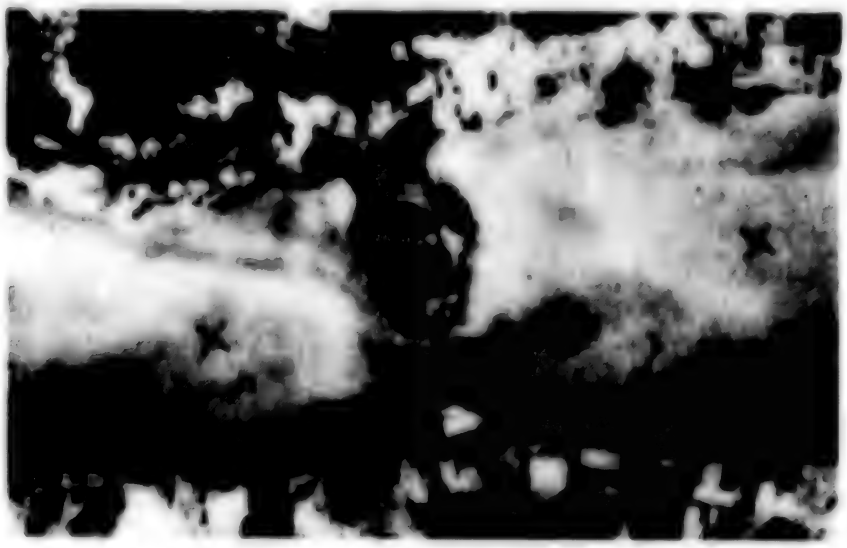
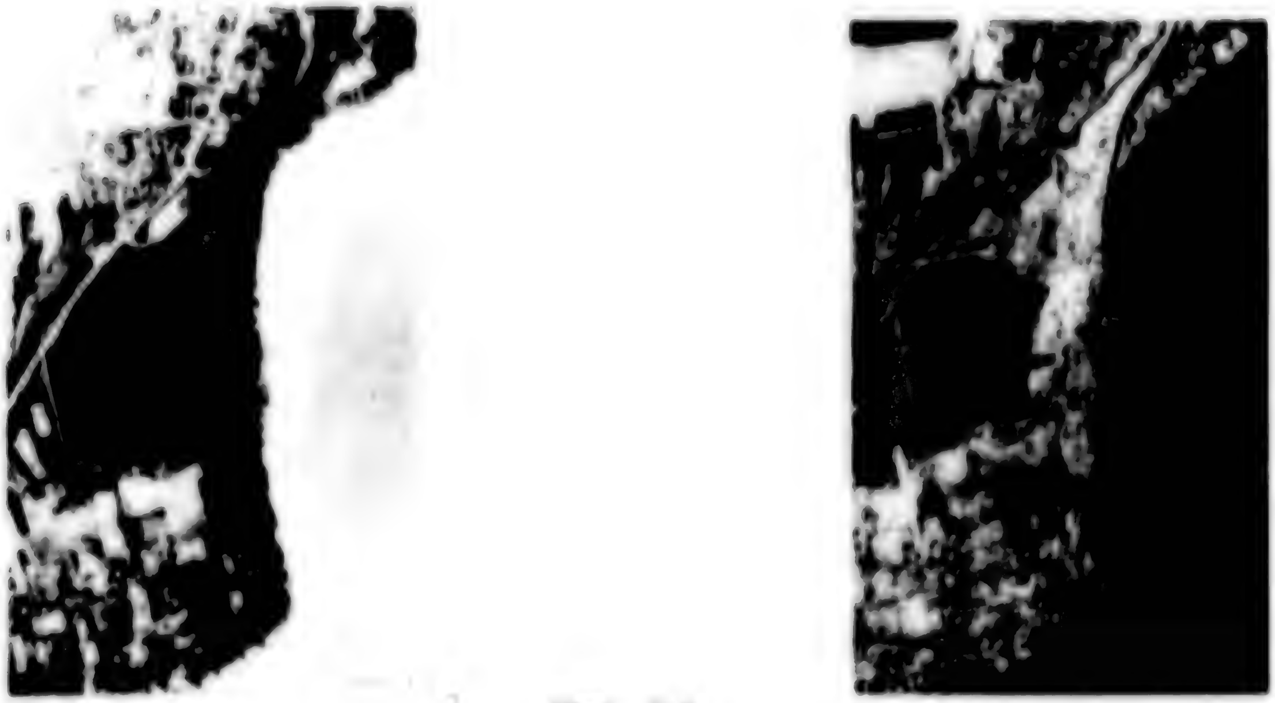


Fig. 1. Party of a photo made from Salyut-6. The Tihany Peninsula is recognizable.



Figs. 2-3

These photos were made from the Soviet AN-30 flying laboratory.

Fig 3. A photo of the same region using infrared-sensitive film, i.e., an invisible frequency range. On this photo it is possible, for example, to distinguish between leafy and coniferous wood in the forest already mentioned. Differences in the color of water also reveal the difference between wavelengths.

[29 Jan 81 p 6: "Photos by Bertanan Farkas"]

Meteorologists were perhaps the first to recognize the potential practical uses of space exploration. Today there are dozens of satellites automatically and continuously sending photos made at various altitudes (from 600 to 36,000 kilometers) showing cloud cover, the birth of hurricanes and other important phenomena.

An Astronaut Sees It Differently

The question which arises is not completely illogical: what is the continued role of astronauts in meteorological research and photographing objects and phenomena specified by meteorologists?

This is the question I asked of Pal Bozo, head of the remote sensing group of the Central Forecasting Institute of the National Meteorological Service, responsible for coordinating the project aimed at the definition of an observation program, primarily for the benefit of the Hungarian astronaut.

At first, the answer is somewhat surprising. Astronauts have many advantages over automated satellites. The first advantage is that a manned spaceship travels in a lower orbit; as a result, the astronaut has a closer view of clouds. Of course, he sees phenomena in full color and also stereoscopically, using both eyes, which is very important. In addition, he is capable of selecting and deciding what is to be photographed. Finally, he can observe phenomena continuously.

The World Meteorological Organization operates an international weather observation service called WWW. This provides meteorologists with photos containing information about very large scale (macrosynoptic) phenomena, obtained from satellites. But related medium-scale, mesosynoptic phenomena are also very important for weather forecasting. Our small country is especially affected by these processes. Our success in recognizing these mesosynoptic processes early enough has an important influence on whether forecasts come true or not.

Chains of Showers, Wave Clouds

This was the starting point for defining the tasks of our astronaut by Hungarian meteorologists. These had to be carried out in part by making color photos using a hand-held camera and in part through observation. Bertalan Farkas made more than 100 photos. Their evaluation is still in progress: they must be compared with other, surface or balloon observations in order to find out the meaning of observed phenomena.

Our astronaut had to concentrate his observations in three areas. First of all, his work was expected to provide data for the forecasting of storm chains which pose the greatest threat to life and property. When more than one storm breaks out (even though a single storm is capable of a great deal of damage, especially because of strong gale winds) and storm clouds line up into a chain, then enormous damage may be expected. Damages may be reduced if warning is provided in time.

Another area where Bartalan Farkas has done meteorological work is the observation of wave clouds. Behind mountains over 900 meters in height, on the side sheltered from the wind, there are usually wave clouds with a characteristic appearance. Their shape, position and density are indicators of the winds and airstreams present in those locations. Since our country is surrounded by mountains, this type of information is very important for us. Our meteorologists are unable to incorporate data on airflows modified by mountains into their forecasts because of the scarcity of data. This work is also the subject of a project called ALPEX involving a great deal of international cooperation. (On this topic, we published a report in our series "Workshops of Hungarian Science" on 25 September of last year discussing the National Meteorological Service.)

Convective Cells

Last but not least, the Hungarian astronauts had to carry out observations regarding the atmospheric phenomena called convective cells. These are circular cloud formations resembling a cell. They come in two varieties: in one, clouds are located around the edge of the cell, while in closed cells the clouds are concentrated at the center of the cell. The diameter of such cells ranges from 10 to 100 kilometers.

Convective cells may be found mainly over oceans and other large water surfaces. Recent research showed that the interaction between oceans and the atmosphere is much more substantial than earlier supposed and the effect of oceans on air circulation is much stronger. Therefore, the generally accepted opinion is that long range weather forecasting is hopeless without considering the effects of oceans.

Bertalan Farkas performed observations and made photographs in each of the three areas mentioned. One of his important observations showed an enormous cloud mass over a region of Africa where, according to the crew of Ryumin and Popov who have spent a long time in space, the air was always clear and dry. True, this surprising phenomenon dissolved after a few orbital revolutions, but it was still a rarity. Aside from that, unfortunately he observed unusually frequent and dense cloud cover. Through his entire flight, the sky was very cloudy. This has not been an obstacle to his meteorological observations but it was a hindrance to his other work.

Of the more than 100 photos we present two, unfortunately only in black and white.

Photo Captions:

Fig. 1 In the original, the clouds are visible before a bluish green background: typical wave clouds. The white clouds are a dew dozen kilometers in length and are perpendicular to the direction of the wind.

Fig. 2 Photo of a cyclone over the Northern hemisphere. Accordingly, clouds are moving counterclockwise. The original photo is green. The black background is outer space; at the edge, the curvature of the Earth is visible.

9164
CSO: 2502/43

SPACE SCIENCES

UDC 528.225:629.783

DETERMINATION OF THE GEOCENTRIC GRAVITATIONAL CONSTANT FROM SATELLITE OBSERVATIONS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 10, Oct 80 pp 9-12

BOYKOV, V.V., KAPLAN, B.L., LUTFULLIN, I.A., NASRETDINOV, K.K. and USTINOV, G. A.

[Abstract] Previous techniques for the determination of the geocentric gravitational constant based on satellite observations suffered from the drawback that the correlation between the major axis of the orbit and the constant tends to unity with a decrease in the orbital eccentricy and the quality of the solution degrades sharbly, necessitating observations in the region of rapid change in the geocentric radius vector. This paper proposes a method which circumvents such difficulties and is applicable to satellites with any orbital eccentricity, including a zero eccentricity. The scale of the geodesic grid generated by photographic observations of satellites is specified by the value of the geocentric gravitational constant; the scale error (on the order of $0.25 \cdot 10^{-6}$) leads to changes in the radius vectors of the satellite and ground station. If the range between the satellite and a ground station is measured, it will differ in the general case from the distance computed from the adjustment coordinates of the station and the satellite by an amount delta-r. This difference is due primarily to the mismatch in the scales specified by the value of the gravitational constant adopted for the adjustment of the photographic observations and the linear measurements. Since the measured ranges are the governing factors for the scale, which is determined by the speed of light (c), the constant can be made more precise by correlating it with c. The scale error in this case characterizes the degree of such mismatching and the value of delta-r can be written as a function of the error in the geocentric gravitational constant which is to be incorporated in the equation for the correction of range measurements. An analytical expression is derived for the precision of the geodesic gravitational constant and it is shown that the correlation of the constant with the major axis of the orbit is insignificant and likewise does not depend on the eccentricity; the correlation with the radius vectors of the stations depends only on the number of stations. The constant is not determined by observations from one station, since its correlation with the radius vector is almost unity. Though no sample calculations or experimental data are given, it is noted that model calculations confirmed the conclusions. Figures 1; references 5: 3 Russian; 2 Western. [73-8225]

UDC 528.2:629.78

DETERMINING THE COORDINATES OF THE POLE AND IRREGULARITIES IN THE EARTH'S ROTATION ON THE BASIS OF OBSERVATIONS OF OBJECTS IN SPACE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 6, Nov-Dec 80 (manuscript received 2 Feb 79) pp 44-51

MASHIMOV, M. M., professor, doctor of technical sciences, and MALETS, K. V., candidate of technical sciences, Military Engineering Academy imeni V. V. Kuybyshev

[Abstract] The authors present the coupling equations for the parameters of the pole, the Earth's rotation and observations of objects in space and then apply them to experimental materials obtained with models. They find that the following factors affect the accuracy of such determinations: random and systematic errors in the rangefinding and angular measurements of space objects and the locations of the astronomical-geodesic observatories; random errors in satellite positions; the number of observatories; the altitude of a satellite's orbit and the time during which the value being determined was refined. They then analyze various combinations of coupling equations and degrees of accuracy of these factors to find the best ways of determining the coordinate of the pole and irregularities in the Earth's rotation. Figures 8; references 3.
[86-11746]

UDC 551.521.8

CHANGES IN F-LAYER STRUCTURE IN THE POLAR IONOSPHERE WITH CHANGE IN THE SIGN OF THE Y-COMPONENT OF THE INTERPLANETARY MAGNETIC FIELD. SVALGAARD-MANSUROV EFFECT IN THE IONOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980 (manuscript received 9 Jan 80) pp 877-898

GAL'PERIN, Yu. I., ZOSIMOVA, A. G., LARINA, T. N., MOZHAYEV, A. M., OSIPOV, N. K. and PONOMAREV, Yu. N.

[Abstract] Model computations of the planetary pattern of characteristics of the polar ionosphere are given, taking into account modern models of magnetospheric convection. The results of direct measurements of the lateral component of convection velocity in the region of the daytime polar cusp, obtained in 1967 from the "Cosmos-184" satellite, were used. These results indicate a reversal of the direction of the zonal component of convection with a change in sign of the interplanetary magnetic field B_y component. It is shown that the change in sign of the IMF B_y component and the accompanying change in the pattern of convection in the polar cap should cause a rapid (10^3 sec) change in the planetary pattern of characteristics of the polar ionosphere at the maximum of the F-region and above it, that is, the Svalgaard-Mansurov ionospheric effect. The amplitude of the variations and their character are determined by the relationship of solar and auroral ionization, and therefore are highly dependent on UT, season

and auroral activity, which makes it difficult to compare computations with experimental data. The article gives experimental data obtained from satellites which confirm the reality of the described ionospheric B_y-effect. Thus, long-term data on ionospheric measurements from the earth and from satellites, together with magnetic measurements, can be used in refining the parameters determining the pattern of magnetospheric convection. Figures 6; references 82: 24 Russian, 58 Western.
[34-5303]

UDC 523.74

MODEL OF LAYER-CELLULAR MOTION IN THE CONVECTIVE ZONE OF THE SUN. III

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 57, No 6, Nov-Dec 80
(manuscript received 5 Apr 79) pp 1295-1301

SAVCHENKO, V. P., Institute of Applied Geophysics

[Abstract] The discussion of Spruit's (SOLAR PHYSICS, 34, 277, 1974) model of the structure of the convective zone of the sun is continued in part III of this study. Here calculations are made of parameters of large-scale layer-cellular motion for this model. A curve is presented for the calculation of $\partial s(\xi)/\partial t$ according to equation (6) in part I. It was found that $s/|\partial s/\partial t_{\max} \gtrsim 10^5$ s. The curve shown demonstrates that with an increase in depth ($\xi < 130{,}000$ km) $\partial^2 s/\partial \xi \partial t$ diminishes monotonically; consequently, larger scales of motion must develop more slowly, have lower velocities, exist longer, be masked better by smaller cells, and be evidenced with greater difficulty on the surface of the sun. A table is presented which summarizes scales of vertical motion calculated according to the s-criterion for Spruit's model. Also given in this table are the mean, most probable and median values of horizontal dimensions computed on the basis of the oblateness of cells, $\eta = 3.56$, found for this model. Also shown are data for application of the T-criterion to Spruit's model and to the semi-empirical model presented in part II of this study. It was found that the s-criterion is better able to select the scale than is the T-criterion. It is, however, more difficult to determine by means of the s-criterion the lower base of a maximum cell. For this a complete and detailed model of the sun is required. It is shown that with an increase in the depth of the base of a cell of one and the same level the oblateness of this cell and its horizontal dimension increase. The mean rate of circulation in a cell is proportional to its horizontal dimension. An equation is presented which makes it possible, from a known most probable rate of circulation of the cellular motion of one layer, to determine this value for all the remaining layers. A table is presented which shows in part how the parameters of cells are altered if the lower level is shifted for some reason up or down relative to the median level determined by the T-criterion. An interesting result is the fact that the values of velocities at lower levels of cells were found to be close to velocities calculated for these depths according to Spruit's model. Several indirect applications of the results to the prediction of solar and geomagnetic activity are discussed. It is recommended that

attention be paid to the following factors when predicting flares in active regions near the strong curved neutral line of the vertical component of the photospheric magnetic field: 1) the sudden increase in the rate of origin of new spots; the motion of the spots themselves, their rotation, for example; and the origin of group satellites; 2) sudden evolution of the structure of large spots corresponding to a shift from one stable state to another in their degradation. The process of expansion which results in background magnetic fields must be controlled to a considerable extend by large-scale quasi-cellular motion of the convective zone, whereby this motion localizes fields unevenly on the surface. An illustration is given of the large-scale magnetic field of the sun obtained by means of the panoramic magnetograph at Kitt Peak Observatory on 4 July 1974. Figures 3; references 14: 10 Russian, 4 Western.
[37-8831]

UDC 523.6+523.745

BRIGHTNESS OUTBURSTS OF COMETS AND SOLAR CORPUSCULAR ACTIVITY

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 57, No 6, Nov-Dec 80
(manuscript received 29 Jun 79) pp 1310-1316

ANDRIYENKO, D. A. and VASHCHENKO, V. N., Kiev State University imeni T. G. Shevchenko

[Abstract] For the purpose of revealing the relationship between the corpuscular radiation of the sun and the activity of comets, a catalog was prepared of brightness outbursts of comets observed during the last 12 solar 11-year cycles. The catalog contains approximately 270 cases of outbursts which have been confirmed by several verified observations. This amount of data made possible a statistical study of the outburst activity of comets and of its relationship to the cyclic corpuscular activity of the sun. It has been demonstrated that the outburst activity of comets depends on the phase of the 11-year cycle of solar activity; maxima correspond to periods of rise and decline. Approximately one fourth of all comets observed during the last 12 solar cycles exhibited outburst activity. The highest frequency of brightness outbursts corresponds to a period of a decline in solar activity. Data are presented which demonstrate that brightness outbursts of comets are of identical intensity at various periods of solar activity. Amplitude distribution curves show two maxima, one corresponding to phases 0.1 to 0.2 in the rise in solar activity, and the other to phases 0.8 to 0.9. The greatest number of outbursts of comets is observed during a decline in solar activity, and the highest amplitudes of outbursts in both a rise and decline. The relationship between comet brightness outbursts and high-speed streams of the solar wind is discussed. A table is presented which gives the position of maxima of distributions, in terms of the phase of the 11-year cycle of solar activity, of various geophysical phenomena of a corpuscular nature, of comet phenomena and of characteristics of the interplanetary plasma. Direct measurements have demonstrated that high-speed streams of solar plasma with particle velocities of approximately 700 km/s exist. These streams are responsible for various geophysical and geomagnetic phenomena. There is a close correlation

between processes in comets and geomagnetic activity. A comparison and study has therefore been made of active phenomena in comets and the characteristics of high-speed streams of solar plasma emanating from the sun. Maximum velocities of these streams are observed during a period of decline in solar activity, i.e., in phases 0.7 to 0.9. Data are presented which demonstrate that a relationship does exist between the outburst activity of comets and these maximum velocities during a period of decline. In the table mentioned above, the combination of positions of all maxima demonstrates the existence of a double wave in the distribution of all the phenomena listed in the table, with the first wave of elevated geophysical and comet-physical activity belonging to the pre-maximum period and sometimes to the period of the very maximum of solar activity, and the second wave belonging to the period of decline. It is precisely during these periods that the maximum number of high-speed streams of solar plasma with mean maximum velocities of 700 km/s are observed. It is also demonstrated that coronal holes can serve as an index of the level of corpuscular activity of the sun at various stages of its cyclic activity. Quasi-stationary high-speed streams of solar plasma are generated from regions of the sun closely adjacent to coronal holes and the presence of the latter can therefore be regarded as a sign of the existence of the former in interplanetary space. The level of corpuscular activity of the sun can be gauged in terms of the total area of coronal holes. Figures 5; references 43: 29 Russian, 14 Western.
[37-8831]

UDC 523.64/75

SHORT-TERM FORECASTING OF PROTON FLARES IN THE ACTIVE AREA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 254, No 6, 1980 (manuscript received 4 Jun 80) pp 1380-1383

AVDYUSHIN, S. I., BERNSHTEYN, P. B., and VAYNBERG, Yu. R., Institute of Applied Geophysics, Moscow

[Abstract] Short-term (less than 3 days) forecasting of such phenomena as proton flares in the active area is related to the prediction of the radiation situation in near-earth space. The authors discuss the problems of predicting proton flare activity for periods of 1-3 days with lead times of 1-3 days. They apply two specialized algorithms to the solution of this problem by pattern identification methods. Based on a real-time test of their forecasting technique for a period of 1 day with a lead time of 1 day (June-December 1979) and a comparison of their results with those obtained by subjective techniques at the Forecasting Center in Boulder, Colorado, the authors conclude that their objective method is much better and is about 95-99% effective. Figures 3; references 8: 3 Russian, 5 Western.
[53-11746]

UDC 523.165

BURSTS OF ELECTRON FLUXES WITH AN ENERGY >200 KeV IN A GEOSTATIONARY ORBIT DURING PERIODS OF GEOMAGNETIC DISTURBANCES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980
(manuscript received 30 Jun 80) pp 941-942

BEZRODNYKH, I. P., KLIMENKO, V. V. and SHAFER, Yu. G.

[Abstract] Using instruments on the "Raduga" geostationary satellite a study was made to ascertain variations in the intensity of bursts of electron fluxes with an energy >200 KeV in a geostationary orbit during periods of geomagnetic disturbances. During the period 1977-1979 the authors repeatedly observed cases of considerable variations in the intensity of such electrons trapped in the neighborhood of such a geostationary orbit. These events occurred simultaneously with geomagnetic disturbances, evaluated on the bases of D_{st} variations. The analysis of these data revealed diurnal variations in the intensity of electrons with a maximum at local midday. During the measurement periods there were no high-energy solar particles and the sensors within the limits of statistical accuracy registered a quiet background of charged particles. The instrument effect in experimental data was excluded. The article illustrates several specific changes in electron fluxes and the corresponding temporal change in the D_{st} index. It was found that anomalously high electron fluxes over the course of several days, against whose background a diurnal variation is observed, are registered both in periods of prolonged existence of a decreased value of the D_{st} index and after a magnetic storm when the amplitude of the D_{st} index in the main phase of the storm attains 150-200 γ. Figures 2; references 2: 1 Russian, 1 Western.
[34-5303]

UDC 581.521

SPECTRA OF LOW-ENERGY PROTONS IN RECURRENT INCREASES ACCORDING TO MEASUREMENTS ON THE 'PROGNOZ-4' ARTIFICIAL EARTH SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980
(manuscript received 10 Dec 79) pp 943-946

ZEL'DOVICH, M. A., LOGACHEV, Yu. I., RYUMIN, S. P. and STOLPOVSKIY, V. G.

[Abstract] Recurrent increases in the intensity of particles with a period of 27 days registered by earth satellites have been observed in interplanetary space since 1964. Their greatest number has been registered during low solar activity, this possibly being associated with a much lesser number of bursts of solar cosmic rays during this period, against whose background it is difficult to discriminate recurrent increases, usually of a lesser intensity. During

1974-1976 series of recurrent increases of intensity of protons with $E_p = 0.5$-20 MeV were observed. The "Prognoz-4" registered increases in the intensity of protons and low-energy electrons during three rotations of the recurrent stream 26 Dec 1975-2 Febraury 1976, 22-30 January 1976 and 16-25 February 1976. Measurements of proton intensity in the energy intervals 30-43, 43-100, 100-300, 300-750 KeV were made with a single semiconductor detector in active shielding before which there was a magnetic filter serving as shielding against electrons with $E_e \lesssim 0.5$ MeV. The intensity of protons with $E_p = 1$-5 MeV was measured using a single n-p-detector. The intensity of electrons with $E_e = 40$-500 DeV was measured by the difference method by an instrument similar to those on the "Prognoz 1-3" satellites. The different increases have different ratios of the intensities of protons and electrons. Two successive increases have different proton spectrum exponents, different character of change in the spectra with time and a different relative content of protons and electrons. These differences can be reflections of the differences in the origin of particles or in propagation conditions. If it is assumed that the source of the recurrent streams is the acceleration of particles in interplanetary space it is necessary to postulate different acceleration conditions for the direct and return shock waves and also their change from solar rotation to solar rotation. Figures 2; references 13: 4 Russian, 9 Western.
[34-5303]

UDC 581.521

LONGITUDINAL VARIATION OF COSMIC RAYS UNDER THE EARTH'S RADIATION BELTS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian No 6, 1980 (manuscript received 21 Sep 79) pp 946-947

ALEKSANDROV, Yu. A., KUZNETSOV, S. N. and RYUMIN, S. P.

[Abstract] In an earlier study (KOSMICH. ISSLED., 15, No 2, 223, 1977) the authors used a single gas-discharge counter aboard the "Cosmos-426" for investigating the distribution of cosmic rays (electrons > 2.5 MeV, protons > 30 MeV) under the earth's radiation belts in the region of excess radiation. There was found to be a dependence of the detector readings on longitude in the northern hemisphere at altitudes 400-700 km, which was attributed to the presence of quasi-trapped particles. It was impossible to obtain the corresponding distribution in the southern hemisphere due to the direct influence of the radiation belts on the detector at the investigated altitudes (bremsstrahlung). The authors have now made a similar analysis of the longitudinal distributions of cosmic rays using the instrumentation carried aboard the "Cosmos-721." The detector consisted of a gas-discharge counter surrounded by a plastic scintillator. This instrument made it possible to analyze two components of cosmic radiation: "highly ionizing" (protons 30-100 MeV and α-particles >100 MeV) and "fast" (protons > 100 MeV and electrons > 2.3 MeV). In contrast to the earlier experiment, the possibility of triggering of the counter by bremsstrahlung was virtually excluded. It was found that the form of the dependence of the detector counting rate in the northern hemisphere on geographical longitude and the form of the dependence of the counting rate at conjugate geographical longitudes in the southern hemisphere do not quite coincide. This noncoincidence is evidently associated with the real structure of the earth's magnetic field because the magnetic field at the particular L-shell can be very different at the same altitude in the two hemispheres. The measurements with gas-discharge counters on the two satellites thus indicated longitudinal variations in the counting rate which in general have a similar character and which are evidently associated with high-energy electrons in the region of excess radiation. Figures 1; references 5: 4 Russian, 1 Western. [34-5303]

UDC 521.13

TWO PARTICULAR KINDS OF SOLUTION OF THE PLANE AVERAGED RESTRICTED THREE-BODY PROBLEM

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 57, No 5, Sep-Oct 80
(manuscript received 1 Mar 79) pp 1070-1077

VERESH, F.

[Abstract] The author discusses two of the three classes of solutions for the plane averaged restricted three-body problem that can be found for rather small values of e'. For small initial eccentricities that are commensurate with e' there is a solution of the libration type, while for initial eccentricities that are close to unity, there is a solution of the unstable type. References 7. [47-11746]

INTERPLANETARY SCIENCES

UDC 523.3+528.73

ABSOLUTE HEIGHTS OF 146 OBJECTS ON THE VISIBLE SIDE OF THE MOON, AS DERIVED FROM SURVEYING DATA GATHERED BY SPACECRAFT IN THE 'ZOND' SERIES

Kiev ASTROMETRIYA I ASTROFIZIKA in Russian No 40, 1980 (manuscript received 20 Jun 78) pp 62-68

VALEYEV, S. G., Kemerovo State University

[Abstract] Using three photographs taken by the "Zond-8" automatic space station and two taken by the "Zond-6" with cameras prepared at the Moscow Institute of Engineers of Geodesy, Aerial Surveying and Cartography, specialists at Kemerovo State University determined the value of coordinate ζ and the absolute height of 146 objects on the visible side of the moon. The author explains the mathematical procedures used and discusses briefly their significance. The most important conclusion he reaches is that the average altitude of most of the "sea" areas on the Moon is actually 0.8 km higher than was previously believed, so that the difference between the altitudes of the "sea" and "continental" areas is less than the difference given by figures from the Tucson selenodetic catalog. Figures 3; references 8: 7 Russian, 1 Western.
[68-11746]

UDC 523.033

RADIANT HEAT EXCHANGE IN THE ATMOSPHERE OF MARS AND THE GREENHOUSE EFFECT

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 255, No 1, 1980 (manuscript received 18 Jul 80) pp 64-66

KONDRAT'YEV, K. Ya., corresponding member, USSR Academy of Sciences, and MOSKALENKO, N. I., Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad

[Abstract] The authors discuss radiant heat exchange in the atmosphere of Mars on the basis of a computer model of the atmosphere's spectra transmission functions, assuming that the planet's solar constant has remained unchanged at 585 $W \cdot m^{-2}$ and that it consists of carbon dioxide and water vapor. For the

generally accepted most probable model of its atmosphere, the greenhouse effect on Mars averages about 10 K. Based on the relationship between the average planetary temperature and atmospheric pressure, the authors conclude that it is quite possible that Mars had a warmer climate in the past and that the deep, valleylike formations on its surface could have been formed by water action. Figures 2; references 7.
[54-11746]

UDC 551.4:523.43

RELIEF AND TECTONICS OF MARS

Moscow GEOTEKTONIKA in Russian No 6, Nov-Dec 80 (manuscript received 19 Nov 79) pp 3-12

POSTNIKOV, D. V., USSR Academy of Sciences Bashkir Branch, Institute of Geology, Ufa

[Abstract] A quantitative analysis is made of the distribution of elevations of the relief of Mars over the entire surface in comparison with available data on the tectonic structure and evolution of Mars. A television photograph chart of the surface of Mars on a scale of 1:25,000,000 prepared by Moroz in 1978, as well as available published data on the elevations of reference points and features of the shape and relief of Mars, was used to describe the relief. Measurements were made of various areas expressed as percentages of the planet's surface, characterized by various elevations. It is emphasized that elevation mark data for the surface of Mars are still not very precise and detailed. The data are averaged for rather large sections. The six large regions of the surface of Mars which have been isolated by means of available data on the relief are discussed individually. These include the polar regions (north and south), the northern plain region, the equatorial volcanic plateau region, the southern continental region, the inland depressions, and grabel-like depressions. A table is given of the distribution of elevations for these major structural regions of Mars as a percentage of the planet's surface. A diagram of the relief of Mars is given in equal-area projection. Regional characteristics of the relief of Mars are discussed and a geological interpretation is given of them. An analysis of the distribution of elevations of the relief confirms the preliminary data indicating the evolution of two types of crust, a continental and oceanic. The equatorial volcanic plateaus situated near the boundary of the continental and oceanic regions can be regarded as regions with an intermediate type of crust somewhat similar to the island arc zones of Earth. The existance on Mars of a system of graben-like depressions has been interpreted as certain evidence of the manifestation of tensile stresses in the crust of Mars. The inland depressions are similar in morphology to lunar maria of the Mare Imbrium type. Evidence is presented which suggests that these depressions are tectonic depressions partly produced by products of magnetism and possibly representing analogues of intracontinental basins of Earth, of the Black Sea and Caspian Sea type. Data are presented on the gravitational field and isostasy of Mars. It is concluded

that Mars is a planet which is intermediate in terms of geological evolution between Earth and the Moon. Approximately two thirds of its surface are represented by structures similar to those which have evolved on the surface of the Moon, and the other third by volcanic and tectonic structures of the endogenic type similar to the structures of Earth. These structures on Mars, however, have been less "spoiled" by subsequent processes of erosion or sedimentation. Mars can therefore perhaps serve in part as a model for study of the earlier stages of the evolution of Earth. Named as priority problems which can be solved by means of automatic interplanetary stations are a detailed study of the relief with a minimum resolution of 0.1 km by means of radio altimeters from satellites, stereophotography and the precise correlation of reference points, and passive and active seismic investigations aimed at an understanding of the internal structure of the planet and at studying the structure of the crust of the most interesting geological regions of Mars. Figures 3; references 22: 15 Russian, 7 Western.
[38-8831]

UDC 523. 164.8

STATISTICAL CHARACTERISTICS OF RADAR BACKSCATTERING FOR SOME ZONES OF THE SURFACE OF MARS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 57, No 6, Nov-Dec 80 (manuscript received 10 Sep 79) pp 1317-1319

KOPTYAYEV, V. I., USSR Academy of Sciences Institute of Radio Engineering and Electronics

[Abstract] Results are given of statistical processing on the "SM-3" minicomputer of published data of investigations of radar backscattering for five zones of the surface of Mars. A characterization is presented of the average reflecting properties of each of the zones studied. A standard program in FORTRAN developed especially by the author was employed. Backscattering characteristics were studied in the 3.5 to 3.8 cm waveband for all zones with additional data at a wavelength of 12.6 cm for zone 5. Conclusions are drawn regarding the reflective properties of the surface of Mars in these zones and the dependence of these properties on the wavelength is traced. Zone 1 is the largest of all according to measurements made of ρ and C, where ρ represents the reflectivity of the surface of the planet in relation to the reflectivity of an ideally conducting smooth sphere whose radius is equal to the planet's, and C is the surface smoothness parameter determined from observations. In zone 1 the surface is rather poorly reflective. Here the surface's relief is evidently distinguished by considerable ruggedness. Zone 2 is located in the southern hemisphere of Mars and is shown to exhibit higher average reflectivity that zone 1. Its narrower backscattering diagram confirms the fact that zone 2 has a smoother relief. Zone 3 is characterized by a mean width of the backscattering diagram almost identical with that of zone 2. The material of its surface, however, has greater

reflectivity than that of zone 2. Zone 4 differs from zone 3 in its closer position to the equator and in greater reflectivity of the material of its surface. Zone 5 is located in the northern hemisphere at the same distance from the equator as zone 4. It is close to zone 4 in terms of reflection characteristics. With an increase in wavelength the influence of irregularities of the relief on the scattering of waves is felt less. Zones 2 to 5 on average all have a higher value of σ_0, a parameter expressing the reflectivity of the surface's material, and a rather narrow backscattering diagram as compared with zone 1. Figures 2; references 2 Western.
[37-8831]

UDC 523.34

SOME PLANETARY REGULARITIES IN THE DISTRIBUTION OF CRATERS ON MARS, THE MOON AND MERCURY

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 4, 1981
(manuscript received 6 Aug 80) pp 929-931

KAZIMIROV, D. A., RODIONOVA, Zh. F. and SITNIKOV, B. D., Geology Institute, USSR Academy of Sciences, and State Astronomical Institute imeni P. K. Shternberg, Moscow

[Abstract] The authors used published maps of Mars, the Moon and Mercury to obtain the coordinates and dimensions of more than 50,000 craters on those three bodies. These data were then used for the automatic compilation, using a graph plotter, of maps showing the density of the distribution of different-sized craters and the features of the location of craters for the three bodies as wholes and for separate sections. For Mars, a regularity was established: a gradual increase in the density of craters of all sizes from the North to the South Pole, which corresponds to a change from the tectonically active to the tectonically passive hemispheres. For the Moon, there is a decrease in the density of craters more than 30 km in diameter from the poles to the equator, accompanied by an increase in the density of craters 10-30 km in diameter. For craters of all sizes, there is a decrease from the poles to the equator. No definite conclusions can be reached about Mercury, since only 45 percent of its surface has been photographed. However, the greatest observed crater densities are in the northern polar area and the 30-60° belt in the Southern Hemisphere. Figures 4; references 6: 4 Russian, 2 Western.
[69-11746]

UDC 535.33:523.42

'VENERA-8' AND 'VENERA-10': SPECTROSCOPY OF SCATTERED RADIATION IN ATMOSPHERE ABOVE CLOUDS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980
(manuscript received 26 Jul 79) pp 899-906

KRASNOPOL'SKIY, V. A.

[Abstract] A method is proposed for computing the principal characteristics of aerosol on the basis of scattering spectra at the planetary limb. Using data from spectroscopic observations on the "Venera-9" and "Venera-10" stations it was possible to ascertain the altitude dependence of the size of particles, their number and volume density in the Venusian atmosphere above the clouds. In the altitude range 70-100 km the radius of the particles varies in the range 1 to 0.1-0.2 μm, the number of particles ranges from 100 to 0.1 cm^{-3}, density varies from 10^{-9} to $5 \cdot 10^{-9}$. Experimental data were used in computing the coefficient of turbulent mixing; this is 10^4 cm^2/sec at 90-100 km. The possibilities of spectroscopic detection of small atmospheric components were compared for different observation geometries. The spectroscopic limits of the content of seven gases at different altitudes were obtained. These data on Cl_2, SO_2, CS_2, NO_2, O_3, Br_2, and S_8 are tabulated. Figures 5, tables 1; references 22: 6 Russian, 16 Western.
[34-5303]

UDC 629.132.1:523.42

TWO-COMPONENT WORKING MEDIUM FOR A FLOATING PROBE IN THE VENUSIAN ATMOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980
(manuscript received 22 Oct 79) pp 914-917

MOSKALENKO, G. M.

[Abstract] The problems involved in regulating the aerostatic force of a floating probe in the Venusian atmosphere by means of two-component working media are examined. The proposed energy-free regulation method involves use of two-component substances with different dew points whose two-phase state ensures a spontaneous regime of ascending-descending movement of the flight vehicle. [illegible] author gives diagrams of state of the evaporating components of the working media and indicates the regions of their effective use at the different altitudes of floating in the Venusian atmosphere. Emphasis is on use of an "ammonia + water" working medium. Analytical expressions are given for determining the parameters of the primary and secondary working media. Since high-pressure cylinders are not required the use of fluids for formation of the aerostatic force reduces the mass of the floating probe to be lifted by the carrier-rocket by more than 20% in comparison with traditional systems of light gases such as hydrogen or helium. The probe can operate in continuous and discrete forms of movement. It can rise and descend without interruption

or stops can be made at desired altitudes during ascent or descent. Figures 2, tables 1; references: 4 Russian.
[34-5303]

CHARACTERISTICS OF THE 'SOYUZ' LAUNCH VEHICLE

Moscow KRASNAYA ZVEZDA in Russian 23 Dec 80 p 4

[Article by Engr-Col L. Nechayuk]

[Text] The "Soyuz" launch vehicle has three stages. The first stage consists of four strap-on units each having a length of 19 meters and a maximum diameter of three meters. The four first-stage engines develop a total thrust of 408 tons.

The second stage of the rocket has a central unit about 28 meters long with a maximum diameter of 2.95 meters. This stage has one four-chamber engine which develops a thrust of 96 tons.

The third stage unit is eight meters long and 2.6 meters in diameter. It has a four-chamber engine with a thrust of 30 tons. The engines of all three stages use an oxygen-kerosene fuel.

The launch weight of the launch vehicle including the "Soyuz" is over 300 tons. Total length is 49 meters; maximum diameter along the fin assembly is 10.3 meters.

CSO: 1866/91-P

CHARACTERISTICS OF THE 'SALYUT' ORBITAL COMPLEX

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 3, Mar 81 p 45

[Excerpt] BASIC CHARACTERISTICS OF THE ORBITAL COMPLEX

WEIGHT	kg
Complex (with 2 transport ships)	32,500
Orbital station (after orbital insertion)	18,900
"Soyuz" manned ship	6,800
"Progress" transport ship	7,000
Scientific equipment placed in orbit directly by the "Salyut" station	1,500
Cargo delivered by "Progress:	
--in freight compartment	up to 1,300
--in fuel component compartment	up to 1,000

GEOMETRIC CHARACTERISTICS	meters
Total length of complex (with 2 transport ships)	29
Length of "Salyut" station	15
Diameter of station (Maximum)	4.15
Cross-section (Maximum, along solar batteries)	17

DESIGN ORBITAL PARAMETERS	
Inclination (degrees)	51.6
Altitude of circular working orbit (km)	350
Altitude of orbital insertion of station (km)	200-270
Altitude of orbital insertion of transport ships (km)	190-240
Total area of station's solar batteries (sq m)	60

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CSO: 1866/90-P

ACADEMICIAN MISHIN ON EFFICIENCY OF EARTH-ORBIT SUPPLY SYSTEMS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 11, Nov 80 pp 42-44

[Article: "The Road Into Orbit"]

[Text] The major arena for the activity of man in space will for a long time remain near-earth space. Its utilization for practical purposes in the interests of the national economy is extremely effective. There is also another reason. Before launching into the distant regions of interplanetary space and mastering the other heavenly bodies, it is necessary to create a reliable base close to the earth, solve the problems related to the technical support of long missions and learn how to live and work for a long time in space.

Our correspondent talked about one of the most important problems in modern space flight with Hero of Socialist Labor and winner of the Lenin Prize, academician V.P. Mishin.

In a few months we will mark the 20th Anniversary of the first manned flight into space. The name of this man is known throughout the world. Our compatriot Yu.A. Gagarin traced the first route in the starry ocean.

It is now no longer necessary to convince anyone of the importance and effectiveness of spaceflight - a new field of human endeavor. Its political, economic, social, scientific, engineering and cultural significance is obvious.

In the immediate future, astronautics will provide for global radio communications and television, navigation of aircraft and ocean going vessels, worldwide weather services and environmental protection services, as well as the widescale study of nature and the natural resources of our planet. Astronautics has given a powerful impetus to the development of all earth sciences. Its impact on scientific and engineering progress increases from year to year. In the more distant future, there will be specialized long term orbital stations and production process complexes, multipurpose satellites and satellites for providing electrical power to the earth, and many others. At the frontier of the third millenium, it will be impossible to conceive of mankind without vigorous activity in space.

However, the development of astronautics and the fate of numerous space programs will be governed to a considerable extent by the organization of a reliable and permanently operating "earth to orbit to earth" cargo bridge, and by the effeciency of the transport systems intended for boosting cargos into space.

The delivery of a payload into a near-earth orbit and overcoming the earth's gravity are the basic energy problems of astronautics. It is obvious that there is still no small amount of work to be done on solving this problem for mankind. It is no accident that K.E. Tsiolkovskiy stated: "The first giant step of mankind consists in flying beyond the atmosphere and becoming a satellite of the earth. The rest is comparatively easy, right to leaving our solar system."

This is actually true. To overcome the earth's gravity, craft are needed which have a colossal propulsion system, large supplies of fuel and consequently, considerable weight and volume of the components.

In order to carry a satellite into orbit, the rocket launched from the earth has to overcome the resistance of the atmosphere and sustain high accelerations and loading. Because of this, it requires a tough aerodynamic design and strong frame. And as is well known, the strength is closely tied to another problem, if you will, the "hottest" problem in space engineering -weight limitations. The weight of the structure of modern space rockets has been reduced to a minimum, amounting to a few percent of the weight of the fully fuelled rocket.

The problem is enormously simpler with the transfer of the spacecraft from a near-earth orbit into a flight trajectory to the Moon or Mars. In this case, the spacecraft is accelerated in airless space, with smaller accelerations, by virtue of which it can have a lighter structure and a light engine. The additional velocity of three to four km/sec can be imparted to it, by means of just one rocket stage.

This is why the major problem is to "become a satellite of the earth."

At the present time, the activity of cosmonauts in orbit is supported by manned transport and automated cargo ships. Because of them, the "Salyut-6" orbital station has been functioning for three years now. Crews of Soviet cosmonauts have set four records one after the other for the duration of space missions and carried out a large volume of scientific and applied scientific research and experiments.

In analyzing the prospects for the study and mastery of space, specialists come to the conclusion that even in the foreseeable future the cargo flow from the earth to near-earth orbits will have to increase a great deal. They link this both to the necessity of supporting the operation of permanent orbital stations and the possible construction of large structures and vehicles in near-earth space.

Up to 25 to 30 kilograms of various materials are consumed every 24 hours on board orbital stations, even when just a few crew members are present. This must include the fuel for the propulsion plants, food products and units for regeneration of the atmosphere. With an increase in the station crews, these expenditures will naturally grow a great deal.

The renewal of station equipment is becoming an important problem, not only for the purpose of replacing equipment which is obsolete or has exhausted its service life, but also for the performance of new experiments. Interesting ideas can occur to the researchers during a mission. New instruments are needed to check them out. The subjects of biological research must likewise be renewed.

In the course of operating orbital stations, it has been found that it is impossible to store film on board for a long time: galactic radiation, although it is slight, exposes the film. For this reason, the exposed film must be delivered to earth as quickly as possible and the stock regularly renewed.

The atmosphere is consumed during intense work in a station. This occurs during the removal of wastes through the air locks and when the cosmonauts go out into open space. For this reason, it is necessary from time to time to supplement the stocks of nitrogen and oxygen.

Fuel is expended for the correction of the station orbit and its orientation. Even when so-called no-consumption orientation systems are present in spacecraft - flywheel, magnetic, gravitational - systems will still be needed which consume a working substance to accelerate the vehicles. And the flight of a station in a specific orientation comprises the majority of the time, when the bulk of the studies are performed: geophysical and astrophysical research.

Thus, the operational service life of an orbital station is actually a direct function of its supply.

This is one factor which explains the intensification of the "earth to space" cargo bridge in the immediate future. And there is another one.

In the initial stage of man's mastery of space, the artificial earth satellites were narrowly specialized: meteorological, communications and navigational satellites were designed, as well as vehicles for studying the natural resources of the earth and ocean. This was frequently done for various departments. This situation could be accepted for a certain period of time.

Now, a trend is being observed towards the development of multipurpose satellites, which are capable of combining the execution of many tasks in the interest of various departments and sectors of the national economy. For example, meteorological and for the study of the natural environment. But such vehicles, equipped with multipurpose scientific equipment, more sophisticated data transmission systems and which are designed for long operational service lives naturally cannot be smaller and simpler than the vehicles now existing.

Provisions are made for the technical servicing, refueling and realignment of the equipment of such satellites directly in space. And it is possible to do this only by using some kind of transport facilities.

The "earth to orbit to earth" cargo flow can also increase substantially through the organization of the production of all possible kinds of materials and products in space, which are of considerable value for science and the national economy.

And finally, the specialists of various nations are increasingly actively studying the problem of designing gigantic satellites to supply the earth with electrical power. These are to a certain extent an alternative way out of the energy crisis. For the practical solution of this problem, it is necessary to lift several thousand tons of cargo into space.

Thus, the creation of a hig pacity "earth to orbit to earth" transport bridge is obvious. And it is no accident that scientists and designers from various nations are actively at work on this.

However, if we take this transport bridge and consider the direction of its cargo flows for the foreseeable future, then we see the following picture: a flow of heavily loaded cargo craft, tanks and refrigerators will move from the earth into orbit, and only a few "Zhiguli" and "Zaporozhets" trickles will come back.

What is this talking about? About the fact that nonreturnable cargo (including the spacecraft themselves) will continue to predominate for a long time over returnable vehicles. Shouldn't this be taken into account in the development of space transport systems? It absolutely should be. And our designers are taking this into account.

Nonreturnable does not in any way mean lost. True, right now a great deal of that which is lifted into space -- the last stages of rocket vehicles, satellites, automated cargo craft and even orbital stations with their equipment -- is destroyed, burning up in the atmosphere when its service life is used up or its operational life expires. And even more objects of artificial origin will remain in orbit for a long time. These are all the possible kinds of satellites and various fragments of rocket vehicles and spacecraft - fairings, adapters, loose parts, etc. At the present time, the number of them in near earth space is approaching 5,000. This has already begun to seriously disturb specialists. With the observed trend towards a constant increase in such objects, a belt could be formed around the earth in 50 years which would be an extremely serious danger to space navigation. For this reason, thought must be given to the fate of such objects. And apparently, much of this will find its application quite soon; it will be used either in its whole form or as space construction material. The capability of such utilization must of course be incorporated beforehand in their structural design. Why not, for example, use the fuel tanks of the last stage of a rocket vehicle directly in space as living quarters for an orbital station following some small amount of retrofitting?

A quite considerable portion of the cargos delivered to the station is now being returned to earth: primarily the materials of scientific studies and experiments. V. Lyakhov and V. Ryumin in the "Soyuz-32" returned even part of the equipment and instrumentation of the "Salyut-6" station which had exhausted its service life. This was done at the request of the designers.

The production of space shops and plants will be added to returnable materials in the future. And although the weight of such cargo will obviously for a long time be less than the weight of the cargos lifted into space, scientists and designers are likewise working on the return problem.

Project plans exist for the equipping of orbital stations with special returnable capsules. Experiments in this direction have already been performed in our country. For example, such capsules were sent to the earth twice from the "Salyut-5".

The "Progress" cargo craft does not now have a returnable vehicle. And why not equip it or another craft of this type with a descent vehicle? This would not be a return to the "Soyuz"; the descent vehicle of an automatic unmanned ship will be much simpler and less expensive: it will not need a life support system, it can enter the atmosphere with enormously greater loads, and finally, its reliability can be lower than for a vehicle with people. All of this together will permit a substantial reduction in the weight of its structure and equipment, and consequently, and increase in the mass of the returnable cargo.

As is well known, the operation of Soviet orbital stations is supported by various facilities which serve to deliver crews and cargos to the stations: these are manned "Soyuz" transport ships and the "Progress" automated ships which play the part of cargo craft, tankers and tow vehicles.

The need for various transport vehicles is due to a number of factors. The same rocket vehicle is used to carry the "Soyuzes" and "Progresses" into orbit. And if the functions of these ships are combined? A manned vehicle, in which the crew is delivered to the station and returned to earth, is equipped with a life support system, high capacity thermal shielding, a controlled descent system and a number of other devices. And this eats up the lions share of the payload delivered into orbit by the rocket vehicle. This is why it is not expedient to use a piloted ship as a cargo vehicle, even an unmanned variant.

The gain in the payload weight is especially perceptible when a nonreturnable craft is used, such as the "Progress", for which there is no vehicle at all for a descent to earth. The space for the descent vehicle was taken by the fuel compartment. And the living compartment of the "Soyuz" was converted to a cargo compartment. Here there are stowage bins in which the cargo is secured. Because of the fact that the "Progress" is not designed for a return to earth, it is free of a number of systems. For this reason, in contrast to the "Soyuz", not just 50 kilograms of cargo (in addition to the cosmonauts) can be lifted into space in it, but rather 2,300 kg.

The mastery of near-earth space, in addition to the operation of long term orbital stations, presupposed the utilization of all sorts of satellite communications systems, television and navigation systems. Satellites will be placed here for astrophysical research and studies of the natural environment and natural resources of the earth. The nature of the tasks which can be performed by these vehicles requires that they be placed in different orbits, at times several thousand kilometers distant from the earth.

But is one thing to boost a vehicle into a low orbit, and quite another to place it in a stationary one. Is it really necessary to have rocket vehicles of different capacities for launching various satellites through space? It turns out that it is not altogether necessary. There is the opinion that it is more expedient to initially place several vehicles in a low, near-earth orbit, and then transfer them to the requisite orbits by means of a tug vehicle. The tug vehicle can be permanently placed in space. It is only necessary to refuel it from time to time.

Thus, yet another space vehicle, an interorbital tug vehicle, can be required to assure the reliable operation of the "earth to orbit" cargo bridge.

The "Progress" automatic cargo ship has already played the part of such a vehicle several times. After docking with the "Salyut-6" station, it still had fuel and its engine was used to raise the orbit of the station.

Along with the existing rocket vehicles, specialists do not preclude the presence of ultraheavy rocket transport vehicles in the arsenal, which are capable of lifting a load of many hundreds of tons into low, near-earth orbits. Their modular construction will permit a wide variation in the energy characteristics, so as not to allow for their inefficient utilization when lifting loads of various weights.

The creation of the arsenal of space transportation tools is a problem of enormous importance. Its solution is tied to the refinement of the propulsion plants, the derivation of new fuels, structural materials as well as progress in the field of control systems. The approaches to the solution of this problem are diverse, but in all cases, the transport systems being worked out should provide for a substantial reduction in the cost of delivery of a payload into space.

The implementation of the Soviet program for space research by means of piloted ships and orbital stations, which started with the legendary flight of the first pilot cosmonaut in the world, Yuriy Alekseyevich Gagarin, as well as the realization of the widescale program for the launches of automatic space vehicles will make it possible for Soviet astronautics to achieve outstanding new scientific successes and extract even greater practical benefit for the nations's economy.

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CSO: 1866/75

UDC 52.06

METHODS FOR THE PRIMARY REDUCTION OF LASER MEASUREMENTS OF DISTANCES TO ARTIFICIAL EARTH SATELLITES

Kiev ASTROMETRIYA I ASTROFIZIKA in Russian No 40, 1980 (manuscript received 24 Jul 78) pp 74-78

KUDLAY, A. G., Main Astronomical Observatory, Ukrainian SSR Academy of Sciences

[Abstract] The preliminary reduction of laser measurements of the distances to artificial Earth satellites consists of two basic stages: 1) computation of the measured distance, allowing for all known systematic errors; 2) smoothing of the results for the purpose of reducing the effect of random errors and rejecting "crude" measurements. Given the present state of the art of laser range finding, only the second stage is of crucial importance: the proper smoothing algorithm must be found. There are two basic types of these algorithms: 1) the measured distances are represented by orthonormalized polynomials; 2) their squares are represented by a modified Fourier series. The author compares the accuracy of the two methods, as applied to observations of the GEOS-B satellite made by the Riga University expedition to Helwan in 1974, and concludes that: 1) the intrinsic accuracy of laser distance measurements is about 1 m, and does not depend on the smoothing method; 2) for preliminary reduction, approximation of the squares of the distances should be preferred over direct smoothing; 3) the two methods are about equally effective. Figures 4; references 7. [68-11746]

UDC 629.7

RESONANCE AND PERIODIC MOTIONS OF A SOLID SATELLITE RELATIVE TO ITS CENTER OF MASS, SITUATED AT A TRIANGULAR LIBRATION POINT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980 (manuscript received 19 Dec 79) pp 832-843

BARKIN, Yu. V. and MARKOV, Yu. G.

[Abstract] In connection with numerous proposals for using trajectories in the neighborhood of libration points of the earth-moon system it is important to

examine the problem of study of the rotational motions of a space vehicle situated either at the libration points in the restricted circular three-body problem or experiencing a stipulated periodic motion near these points. The authors have continued their work on this problem (see Yu. V. Barkin, KOSMICH. ISSLED., 18, No 2, 191, 1980; Yu. V. Barkin, Yu. G. Markov, PRIKL. MATEM. I MEKH., 44, No 3, 1980). This involved investigation of different types of resonance motions of an axisymmetric satellite and a satellite having triaxial ellipsoidal inertia relative to its center of mass situated at the libration point L_4. The basis for the work was the Delaunay-Hill averaging method. The averaged equations are integrable in the case of an axisymmetric satellite and generate an integrable subsystem of differential equations for a satellite with a triaxial ellipsoid of inertia. The integrable averaging schemes made it possible to ascertain the principal qualitative peculiarities of possible types of resonance motions. In particular, a study was made of the conditions under which the averaged equations allow periodic solutions. A numerical example is considered for a space vehicle situated at the libration point L_4 applicable to the earth-moon system. Figures 7; references: 7 Russian.
[34-5303]

UDC 629.782

APPROXIMATE SOLUTION OF THE FILTRATION PROBLEM IN ATMOSPHERIC CONTROL OF SPACE VEHICLE FLIGHT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980 (manuscript received 25 Sep 79) pp 844-850

BARANOV, V. N. and GAVRIKOV, V. G.

[Abstract] The authors give a detailed description of an algorithm for evaluating the vector of state of a space vehicle moving in a planetary atmosphere. Recommendations are presented on forming of the properties of an expanded vector of state with allowance for a great number of diverse random perturbations. A proposed modification of the Kamman filter which takes into account the properties of mathematical models of space vehicle motion is theoretically substantiated. Recommendations are also presented on organizing the data processing block in an optimum system for control of the descent module. The results of statistical modeling (on an electronic computer) of the functioning of an optimum data processing block in a system for the autonomous control of space vehicle flight in the atmosphere are also given. The proposed approximate method for solving the filtration problem thus makes it possible to solve the navigational problem, an important part of the overall problem of synthesis of optimum stochastic control of a space vehicle during descent in the atmosphere. The effectiveness of the solution method is determined by the possibility of obtaining a stable, convergent process of obtaining evaluations for the components of the expanded vector of state of the system which then must be used in the optimum control block proper for computing the controlling effects. Figures 2; references: 4 Russian.
[34-5303]

UDC 629.7.012.2

STABILITY OF STATIONARY MOTIONS OF A GYROSTAT IN A CENTRAL FIELD

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian No 6, 1980 (manuscript submitted 1 Apr 80) pp 933-935

GEVORKYAN, S. Kh.

[Abstract] A study was made of translational-rotational motion of a gyrostat in a central Newtonian force field. The center of attraction o_1 is used as the origin of the fixed coordinate system $o_1\xi\eta\zeta$ and the center of mass of the body o is used as the origin of the fixed coordinate system $ox_1ox_2ox_3$, whose axes are directed along the principal central axes of inertia of the body. In addition, a moving coordinate system oxyz is introduced, the z-axis being directed along the straight line o_1o, the x-axis being directed along the straight line perpendicular to the z-axis and parallel to the $o_1\xi\zeta$ plane in the direction of motion of the center of mass. The position of the gyrostat in a fixed coordinate system is determined by the spherical coordinates R, χ, σ of the center of mass o and the Euler angles θ, φ, ω, determining the position of the body in the coordinate system oxyz. The satellite motion can be described by using the variables R, χ, σ, θ, ψ, φ as the Lagrangian coordinates, as well as the angle α of relative rotation of the rotor. Procedures are proposed for finding the stationary motions of the gyrostat in the considered formulation. Equations are derived for describing the stationary motions of the satellite-gyrostat. The adequate conditions for stability of the considered stationary motions are derived. It is shown that the region of stability for the satellite-gyrostat can be considerably expanded. Figures 1; references: 2 Russian. [34-5303]

UDC 629.78

REFINEMENT OF THE DECREMENT OF ATTENUATION OF ANGULAR VELOCITY OF ROTATION OF THE SEO ARTIFICIAL EARTH SATELLITE BASED ON AN ANALYSIS OF OBSERVATIONS OF THE 'ARYABHATA' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 6, 1980 (manuscript received 9 Nov 78) pp 935-937

DRANOVSKIY, V. I. and YANSHIN, A. M.

[Abstract] The design parameters of the second Indian artificial earth satellite (AES), a satellite for earth observation (SEO), in many respects coincide with those of the "Aryabhata" satellite. A comparative analysis of the computed and observed behavior of the first Indian satellite now makes it possible to ascertain the damping coefficient more precisely and to employ this value in increasing the accuracy in evaluating the decrement of attenuation of angular velocity for the SEO. The authors gave analytical data on this problem in an earlier study (KOSMICH. ISSLED., 33, No 3, 1975). The calculations for the new vehicle were made taking into account that the configuration of the two Indian satellites is virtually identical. The SEO will be launched into the same

satellite orbit as the first, but it will be an oriented vehicle. The good agreement between the computed and actual damping of angular velocity of rotation of the "Aryabhata" has made possible a substantial reduction in the supplies of working medium for the SEO jet orientation system and during the entire lifetime of the vehicle it whould be possible to maintain its orientation constant with a deviation of no more than 3° from the planned value; the nutation angle should be held constant in the range ±1°. Calculations are presented here for evaluating the decrement of attenuation of its kinetic moment modulus. Three orientations, including the initial orientation, should be adequate for maintaining the angular velocity of satellite rotation within the stipulated interval for a period of a year. Figures 2; references: 3 Russian.
[34-5303]

UDC 629.78:521.1

PERTURBATIONS OF RESONANCE SATELLITES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian Vol 19, No 4, 1980 (manuscript received 25 Feb 80) pp 86-89

SOKOLOV, L.L. and TITOV, V. B.

[Abstract] The authors discuss several aspects of the evolution of resonance satellites acted upon by perturbations from the geopotential's harmonics. They limit their discussion to 12-hour satellites with a low degree of orbital eccentricity and use the problem of two stationary centers as the intermediate orbit. They show that the evolution of the resonance variable, which is a function of the average anomaly, the pericenter's longitude, the Earth's angular velocity, time and the longitude and the ascending node, depends strongly on the orbital inclination. Figures 1; references 3: 2 Russian, 1 Western.
[48-11746]

UDC 535.24

INVESTIGATION OF THE SHAPE OF THE 'PAGEOS' SATELLITE'S SURFACE ON THE BASIS OF ELECTROPHOTOMETRIC OBSERVATIONS

Kiev ASTROMETRIYA I ASTROFIZIKA in Russian No 40, 1980 (manuscript received 16 Aug 78) pp 78-89

BRATIYCHUK, M. V., YEPISHEV, V. P. and MOTRUNICH, Ya. M., Uzhgorod State University

[Abstract] The authors' work is in the nature of an experiment to determine the possibility of using electrophotometry to investigate the surface of an artificial earth satellite. They chose the "Pageos" for several reasons:

its shape is that of a simple sphere, with known dimensions, reflection coefficient and mirror component of the reflected light. After being the subject of much electrophotometric research, it somehow "broke up" in the summer of 1975 but reappeared that autumn accompanied by several small objects that were assumed to be pieces of the original satellite. Using 40 of 48 shine curves obtained by observations of the satellite from 14 November 1975 to 5 May 1976, the authors attempt to determine the changes in its period of revolution and surface, and present a figure showing changes in its surface during orbit. Figures 10; references 14: 7 Russian, 7 Western.
[68-11746]

UDC 528.489:(522.59:621.396)

GEODESIC REFERENCE GRID FOR THE RATAN-600 RADIOTELESCOPE

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 8, Aug 80 pp 18-23

LOBATORIN, O. P. and SHIROV, F. V.

[Abstract] The Ratan-600 radiotelescope is centered in a geodesic reference grid consisting of a pair of concentric regular polygons formed by plan and elevation points. The outer periphery is composed of 12 plan points at radial distances of 288 m; these radii correspond to the direction of the antenna feed rail tracks. The center position is checked with 6 plan points formed by a regular hexagon with sides of 96 m, with points also at radial distances of 96 m. The azimuthal orientation is based on an astronomically determined line and the 12 elevation points are arranged uniformly around a 264 m radius circle at equal distances from the inside plan and elevation points. The precision of the linear measurements of the grid radii is characterized by a mean square error of 0.4 mm; the elevation grid assures the setting of the axes of the circular reflector elements in the horizontal plane with a mean square error of 0.3 mm. The present paper is a statistical study of the stability of the length of the grid lines, the plan points, the position of the center and the grid stability as a whole. The analysis is based on repeated measurements made during 1973, 1975, 1976 (two cycles of measurements) and 1977 (184 measurements in all). The maximum mean square noted in the line measurement precision was 0.22 mm for the 288 m line. The shift of the reference benchmarks with time is plotted (expressed in mm) for the various sets of measurements and benchmark numbers. The stability of the central angles which characterize the stability of the radial line azimuths between measurement cycles has a mean square value of 0.2" and the central angle azimuth can be transferred with a precision of 0.35". The leveling errors are normally distributed and the technique used here makes it possible to ascertain benchmarks which have changed in elevation by more than 0.17 mm between measurements. The reference geodesic grid is found to be a reliable base for the alignment of the Ratan-600. Figures 4; references: 7 Russian.
[72-8225]

EARTH SCIENCES FROM SPACE

Moscow PRIRODA in Russian No 11, Nov 80 pp 3-9

/Article by Aleksandr Vasil'yevich Sidorenko/

/Text/ Academician Aleksandr Vasil'yevich Sidorenko is a vice president of the USSR Academy of Sciences, director of the Academy's Lithosphere Institute, and chief editor of the magazine ISSLEDOVANIYE ZEMLI IZ KOSMOSA /Investigation of the Earth From Space/. He is a specialist in the fields of Pre-Cambrian lithology and problems in the development and integrated utilization of our country's mineral raw material base, as well as the author of works on the genetic types of continental deposits in desert areas, ancient weathering crusts, and the Earth's crust as part of man's environment. He is developing a new field: the lithology and sedimentary geology of the most ancient metamorphic rocks. Sidorenko is a foreign member of the GDR, Hungarian People's Republic and People's Republic of Bulgaria academies of sciences. He is an honorary doctor of the Polish People's Republic's Mining and Metallurgical Academy, president of the All-Union Mineralogical Society, and a Lenin Prize laureate. He has had the following articles published in PRIRODA /Nature/: "Sedimentary Geology of the Pre-Cambrian" (No 6, 1976), "Meetings With D.S. Belyankin" (No 8, 1977) and "For International Scientific Cooperation in the Pacific Ocean Area" (No 8, 1980).

When the first spaceships began to fly, it seemed to naturalists concerned with natural terrestrial processes -- and even those of us who had mastered the various remote-controlled aerological methods for studying the Earth -- that cosmonautics was an area for the physical, mathematical and technical sciences. At that time it was difficult to imagine that spaceflight would have such a great effect on the natural sciences. However, very little time passed before we realized that space research is of tremendous importance for modern geography, geodesy and cartography, geology, meteorology, oceanography, the study of water resources, vegetative cover research, agronomy, ecology and many other areas of scientific and economic activity. In short, the results of the flights of spacecraft -- both manned and unmanned -- are having a substantial effect on all sciences concerned with the Earth itself.

Investigations of different natural phenomena, objects and processes from space have yielded so much fundamentally new material for the natural sciences that we can speak of a new stage in their development. We have seen the appearance of such new concepts as space cartography, space geology, space oceanography, space land hydrology and so on. This in itself underlines the fact that space research has resulted in a radical transformation of the natural sciences. However, the effect of the new technology is being felt not only in each separate branch of natural science, but in all of natural science as a whole.

The great visibility of Earth's surface from space and the simultaneity of observations of the surface when it is in different physical states provides the investigator with a number of new capabilities. First of all there appeared what we now call the features integration effect; that is, when observed from space, individual and disconnected elements on the Earth's surface acquire a certain distributional regularity. There has appeared the possibility of more or less inspecting the depths of the oceans and land masses from space. Of substantial importance for research is the possibility of making simultaneous observations of rapidly occurring processes in the Earth's atmosphere, hydrosphere and soil and vegetative cover. All of this is creating new and favorable prerequisites for the development of the natural sciences by means of methods for the remote sensing of the Earth from space. The natural sciences are acquiring a new character, because cosmonautics is giving us new methods of perception, opening new horizons for the development of science, and giving us the capability to change from a descriptive expression of facts and phenomena to precise qualitative and quantitative evaluations. We now have the right to talk about space natural history and space earth sciences.

The new stage in the development of the natural sciences did not come about by accident. It was prepared for by the entire path of the development of science and technology. On the whole, the conditions for the passage of natural science into the new state can be formulated in the following manner.

1) Man -- or investigative equipment created by him -- went beyond the Earth's boundaries; near-Earth space is being mastered systematically and expeditions to the other planets are being sent out regularly. There has appeared the ability to look summarily at the Earth from off to one side, encompassing it with a single glance. This has demonstrated to us quite convincingly how small Earth is in comparison with the Universe and how irregularly it has been mastered by man, how nature has been wounded, and how important the new development of the natural sciences is right now.

2) In turn, the level of development of the natural sciences has now become quite different. Long ago the natural sciences proceeded from inventorying and describing individual natural phenomena and processes to the establishment of common (for a given science) laws for the development of a natural object. There was a sharp increase in the numbers of instruments used in the earth sciences, and ever more information is expressed in terms of numbers and measures.

3) The information that is obtainable as a result of this has reached such a scale that it can be processed only by new, automated facilities utilizing mathematical methods. This makes it possible to operate with large volumes of data quite rapidly.

4) Mankind is beginning to realize more and more the limited nature of planet Earth's resources and, at the same time, is experiencing an ever increasing need

for them. From this emanates the necessity of taking from nature in such a fashion as to satisfy the needs to the maximum extent while inflicting the minimum damage on nature.

All of this, taken together, means that the natural scientist is faced with new problems and must try to comprehend the present state of development of the natural sciences at the new boundary of the development of human thought. It seems to us that the time has come to raise our knowledge of Earth to a new level, with special emphases on the complex field known as the earth sciences.

The term "earth sciences"[1] was previously understood to mean a section of physical geography concerned with studying the Earth's geographic shell on the basis of the most generalized features of its composition, structure and development. However, the rapid development of the natural sciences at the end of the last century and in the first half of this one resulted in a great differentiation among them and disrupted the lines of communication between them. Natural history lost the capability of discussing many terrestrial phenomena as a whole. Actually, of course, our planet has developed over the last 3.5 billion years as a unified whole that is the sum of its atmosphere, hydrosphere, lithosphere and biosphere. The inspection of Earth from space gave us the ability to examine natural bodies, processes and phenomena as a unified whole on the basis of the interrelationship and interconditionality of natural processes; that is, to return to the earth sciences, but on a new basis: space earth sciences. We understand this to mean the disclosure by space methods of the natural processes occurring on planet Earth and their interrelationship, interconditonality, and dialectic unity and contradictions.

Space earth sciences use remote methods to study the interrelationship and interdependence of the phenomena and processes taking place in the Earth's atmosphere, biosphere and lithosphere. I would again like to emphasize that space earth sciences assume the unity of remote and contact methods. Phenomena defined from space must certainly be confirmed by investigations on Earth. With respect to the study of natural processes on Earth, a rather broad term has come into use: the "terrestrial-space stack." It includes the complex of Earth investigations from space and high- and low-flying aircraft, as well as the interpreting of the images that are obtained, accompanied (when necessary) by geophysical and drilling investigations of the Earth's depths under the continents or a complex of deep soundings of the aqueous shell where the oceans are concerned.

Space earth sciences are not space natural history. The latter term refers to a broader scientific branch that includes not only the Earth, but all of nature as a whole. It seems to use that space earth sciences are one of the fundamental sciences concerned with terrestrial processes that, in the end, is directed toward satisfying the needs of mankind.

As with every other science, space earth sciences have their own investigative methods and goals. As we have already stated, the main investigative method of space earth sciences is a combination of the entire gamut of remote methods with terrestrial investigations.

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[1] This term was introduced by the German geographer K. Ritter (1779-1859).

In general form, the goals of the new science appear to us to be as follows.

Integration of the rules of all the natural sciences concerning the Earth (space geology, oceanography, geography, ecology and so on) in order to establish the rules governing the common processes taking place in the Earth's atmosphere, hydrosphere, lithosphere and biosphere, as well as the disclosure of the interrelationship and interconditionality of these processes and phenomena. There is no doubt that in future formulations the goals and problems, as well as the investigative methods themselves, will be refined and developed.

Let me explain this concept. The more advanced the space earth sciences are, the better we begin to understand the interrelationship between the deep processes taking place in the depths of the Earth or the ocean and those taking place on the surface, and the more we are convinced that the surface of the Earth (and also, obviously, the ocean) reflects the deep processes occurring in the depths of the planet, which are predetermined by the entire path of the protracted evolution of the Earth's crust.

We are beginning not only to understand the interrelationship among natural phenomena on Earth, but also to rank (classify) them according to degree of importance, interdependence and priority.

I could present many examples of this interrelationship and interdependence. Using my own geological experience, I will present only one example of the dependence of the geological structure of the relief and the soils, vegetation and water regime of the surface on the deep processes taking place within the Earth.

It was determined long ago that the Earth's lithosphere has a block-type structure and consists of separate blocks belonging to different classes. Block-type uplifts that appeared as the result of deep tectonic processes determine the geomorphological features of the Earth's surface and its relief and soil and hydrological conditions and, following this, the distribution of vegetation and biocenoses. This is expressed excellently in the interrelationship of the Earth's vegetative cover with the soil, hydrological and geological structures of each large block of which the Earth is comprised. Such a relationship has been proven for the sub-Arctic, the taiga, Siberia, the deserts of Central Asia and the plains in the European part of the USSR. The cause-and-effect relationship between the two dialectically contradictory processes -- deep, endogenic processes in the depths of the Earth and processes caused by climatic conditions that are reflected in the character of the relief -- was established previously. However, it is now seen particularly clearly because of investigations conducted from space.

For example, on a map of the faults in the USSR's territory it is quite obvious that the hydrographic network of the two continents involved is a direct consequence of deep geological processes taking place in the depths of the planet. The beds of rivers (large ones, especially) are a reflection of the Earth's fault tectonics. All large rivers flow along fault zones. Some fault zones contain seismically active regions. Many large lakes have appeared in areas where large blocks have subsided. Mountains are the result of intensive tectonic processes, folding and uplifts; that is, deep processes. Significant plains (and, sometimes, swamp) areas form on separate blocks that have been in a stable position for a long time.

The Earth's topography is the result of interactions among the Earth's external and internal forces. The climatic conditions imposed on the topography determine the distribution of moisture and plant cover; that is, what we call the landscape.

In general form, we have long known of the relationship between the geological structure of separate sections of the Earth caused by geological processes, surface relief created by a combination of endogenic and exogenic processes in certain natural climatic zones, the distribution of water on the land, and the distribution of flora and fauna. However, its discovery took several decades of work on the part of large collectives of natural scientists, while a look from space or pictures from space make it possible to perceive this regularity in only several dozen orbits around the Earth. This general regularity of the relationship between different elements on the Earth's surface now needs to be developed and worked out in detail, so that within it we can search for new quantitative and qualitative regularities on the new basis of information from space in the form of photographs or other pictures of all these landscape elements.

It is still possible that we will soon discover a relationship between the Earth's physical properties and the distribution of atmospheric phenomena over its surface. We have already begun to collect statistical data on the frequency of repetition of cloud cover of different degrees of intensity in different parts of the Earth (deserts, polar and mountainous areas and even fault zones and zones with anomalous gravity). The establishment of relationships between atmospheric phenomena and geological structures and climatic zones is quite probable, since space research makes it possible to study processes that take place simultaneously and with great rapidity, while automated processing systems make it possible to process large amounts of information rapidly.

There are sufficient examples to prove the usefulness of space methods for studying the Earth. It is time to move on, from separate examples to systematic, integrated investigations of natural phenomena and processes. It seems to use that great opportunities are opening up here. The automated processing of space pictures using mathematical methods makes it possible to use a mathematical language to express the relationship between different elements on the face of the Earth and to demonstrate the role of the geological, geomorphological, biogeological and other processes that created the Earth's contemporary surface. From quantitative evaluations of one natural phenomenon or another on the surface we can move on to an evaluation of its rate of occurrence and duration; that is, in the final account we can derive equations for natural processes, discover their conformity to rules and make predictions.

This seems to me to be the main purpose of the space earth sciences. I, as a geologist, considered the new direction in the natural sciences -- the space earth sciences -- primarily from the viewpoint of a geologist and looked for relationships between geological, soil and biological processes. However, it is also possible to formulate other and no less important problems. Experience has shown the necessity of developing space methods for application to agriculture, land reclamation and fishery management.

Space earth sciences appear to me to be a science consisting of two or three layers of knowledge, the foundation of which is the classical earth sciences: geology, geography, ecology, oceanography and so on. In the next stage these sciences will

Space Earth Sciences

Planet Earth

Space Geology	Space Meteorology	Space Hydrology	Space Biology
Lithosphere	Atmosphere	Hydrosphere	Biosphere

have space methods available and will become space geology, geography, ecology and oceanography. The integration of the conclusions of these separate space earth sciences will produce a new scientific field -- space earth science -- that will become the apex of the pyramid of sciences concerning the Earth.

There was a time that is called the time of the great geographic discoveries. Thanks to cosmonautics and the development of space investigations of the Earth and the Universe, it seems to us that it is necessary to speak of the era of the space earth sciences, which will give us yet many more new and great discoveries. We are entering an age of great space discoveries about nature.

I would like to conclude with that with which I began. When we began to master space we assumed that it was, above all, a technical problem, but time has shown us differently: cosmonautics is not only a child of the scientific and technical revolution. Cosmonautics itself marked the beginning of a revolution in the earth sciences. Thus, the technical and natural sciences are merging into a unified process of perception, and it is in this that we see a great future for the development of human thought.

In almost all fields of human knowledge, cosmonautics is now causing such radical changes that we have all the necessary grounds for talking about the space revolution in science and technology. As of yet, we probably have not fully realized the new stage of knowledge we have reached through cosmonautics and have not yet drawn the appropriate conclusions.

[Photograph captions]

Africa. Ancient volcano crater from an altitude of 350 km. The picture was taken by cosmonauts G.M. Grechko and Yu.V. Romanenko on board the "Salyut-6"-"Soyuz" space complex.

Forest fire cells and burned-out sections of plant growth in Western Siberia.

Discharge of turbid water into the Black Sea. This picture can be used to evaluate detrital deposits.

Obskaya Gulf. Because of the clear depiction of the hydrographic network, this picture can be used to define more precisely the total area of the drainage system's basin and the density and extent of the network of small rivers.

Central Kamchatka. The hydrological network and large faults in the Earth's crust are quite visible. This picture has been used to determine the geological structures in this region.

The four preceding photographs were taken by satellites in the "Meteor" system and were published in ISSLEDOVANIYE ZEMLI IZ KOSMOSA, No 2, 1980.

Lake Zaysan in Eastern Kazakhstan from an altitude of 350 km. The photograph was taken from the "Salyut-4" space station by cosmonauts P.I. Klimuk and V.I. Sevast'yanov.

The Sargasso Sea in the area of the Andros Islands /sic/ from an altitude of 350 km. This picture was taken by cosmonauts G.M. Grechko and Yu.V. Romanenko on board the "Salyut-6"-"Soyuz" space complex.

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AUTOMATED INFORMATION SYSTEM AT 'PRIRODA' CENTER

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 11, 1980 pp 51-55

KRASNOV, V. I., RESHETOV, Ye. A. and FADEYEV, I. N.

[Abstract] An automated information retrieval complex (AIRC) is being developed at the State Center "Priroda" for organizations concerned with studies of natural resources of the earth. Due to expansion of exploration of these resources using spacecraft to take films of earth using several cameras at a time, different types of film, and yielding pictures that differ from ground-based photography, very large amounts of data must be processed. The first section of the AIRC has been operating for several years and performs the following functions: stores blocks of data about quantitative and quantitative parameters of pictures taken from space, informs users on a regular basis or upon request about availability and nature of information about any part of the nation contained on film taken from space, synthesizes information, checks accuracy and fulness of data furnished to clients. The structure of the AIRC is described and illustrated. Operation of the first section of the AIRC has saved 280,000 rubles in the first year, relieving 80 people of manual processing work, and an increasing number of organizations is using it. It is suggested that the knowhow gained with operation of this system can be helpful in developing similar systems in other sectors. Figures 3.
[45-10,657]

UDC 528.711.112

USING THE INFORMATION CRITERION FOR PURPOSES OF ANALYZING AERIAL PHOTO SYSTEMS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 6, Nov-Dec 80 (manuscript received 30 Oct 79) pp 52-56

ALMAZOV, I. V., reader, candidate of technical sciences, and ALTYNOV, A. Ye., engineer, Moscow Institute of Engineers of Geodesy, Aerial Surveying and Cartography

[Abstract] Information methods of evaluating the quality of a photographic reproduction are a new approach to the solution of this problem. Their main

advantage is that they can be applied to any aerial photogaaph as long as the conditions under which it was taken are known. Within the framework of information theory, a photographic image is a random fie d of distribution of the densities of its elements in the plane of the photograph. The authors explain the mathematical apparatus used to evaluate the quality of aerial photographic systems and then apply them to several such systems by way of illustration. They conclude that the use of the information criterion makes it easier to evaluate the properties of aerial photographic systems under rapid analysis conditions, that its sensitivity is commensurate with other quality evaluation methods, and that quality evaluations by this method agree quite well with those made by other criteria, particularly resolution. Figures 2; references 4.
[86-11746]

UDC 528.711.1--778.6

POSSIBILITIES FOR IMPROVING THE QUALITY OF AUTOMATIC IDENTIFICATION OF IDENTICAL SECTIONS IN STEREOPAIR PHOTOGRAPHS THROUGH THE USE OF COLOR CHARACTERISTICS OF PHOTOGRAPHIC IMAGES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 6, Nov-Dec 80 (manuscript received 12 Feb 79) pp 56-63

ZHURKIN, I. G., reader, doctor of technical sciences, and SHAVEN'KO, N. K., candidate of technical sciences, Moscow Institute of Engineers of Geodesy, Aerial Surveying and Cartography

[Abstract] For various reasons, the use of automatic equipment to identify identical objects in black-and-white stereopair photographs is not very effective. The use of color photographs has three advantages: they have a potentially higher information content; a color tone has a higher degree of invariance in comparison with the photographic image's density characteristics and in relation to changes in the surveying conditions; greater detail contrast can be achieved. The authors analyze color stereopair photographs and find that the use of color tone as a feature for identifying identical points increases the linearity of the relationship between the left and right photograph scanning signals, which eliminates distortions of the cross-correlation function and improves the reliability and accuracy of the identification in comparison with black-and-white images. Figures 7; references 3.
[86-11746]

UDC 528.711.1(202):(528.94:911.2)

APPLICATION OF SPACE PHOTOGRAPHIC DATA TO THE STUDY AND MAPPING OF ANTHROPOGENIC LANDSCAPES

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 8, Aug 80 pp 47-54

SKATERSHCHIKOV, S. V.

[Abstract] Anthropogenic natural and territorial structures which can be ascertained in photographs of the earth taken from space are defined as any landscape newly created by man or any natural complex which man has influenced either directly or indirectly. Small scale space photographs reveal such structures and allow for the approximate determination of the degree to which they are affected by human activity as well as the assessment of any changes which have occurred. Examples illustrating such applications of data from "Salyut" satellites are shown: photographs from the "Salyut-4" were interpreted to produce a map of the southern Turkmen region showing anthropogenic formations and their consequences (irrigated oasis fields, agricultural lands, populated points, irrigation canals, water reservoirs and roads; affected areas include strong secondary salinization regions with an elevated ground water level, boggy areas with communities of hydrophytes in the region affected by the Karakum Canal, lakes formed at points where irrigation waste waters accumulate, etc.). A fragment of an anthropogenic map of the Crimean peninsula compiled from space photographs from the "Salyut-4" also shows geological structures and a wide variety of areas affected by human activity. An example of the anthropogenic interpretation of space photographs taken at different times shows the filling of the Sarykamys excavation based on photos from the spring of 1974 and 1976. Follow-up photographs taken in 1978 from the "Salyut-6" confirmed earlier analyses of the tendency of the Amu Dar'ya to dump water in the riverbed of the Dar'yalyk. The general discussion of these materials concludes that information obtained from space photography can reveal changes in the status of the environment and evaluate any measures proposed for the protection and efficient exploitation of natural resources. Figures 4; references: 14 Russian.
[72-8225]

UDC 528.711.11.086.6

GEOMETRIC CALIBRATION OF MULTIBAND PHOTOGRAPHIC EQUIPMENT

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 8, Aug 80 pp 37-42

YUROV, V. I.

[Abstract] The elements used for the internal orientation of photographs of the earth's surface taken in several spectral bands by multiple camera systems such as the MKF-6 include: 1. Those for the mutual orientation of the photographs in the various bands; 2. The focal distances of the cameras; 3. The coordinates of the main reference point for each photo; 4. The distribution of the distortion over the field of a frame; 5. The difference in the time synchronization of the exposures of the various cameras. An analytical expression is derived

to relate the coordinates of image points in different bands. The basis of the technique proposed for the determination of the main point of a photograph is collimator measurements of the directions of the paraxial rays of the objective (in both directions), the measurements of the angles between these directions and the calculation of the position of the viewing ray which coincides with the direction to the main point of the photograph. The proposed calibration technique was used to study the parameters of the internal geometry of the nine-channel LKSA-3 camera used for spectral polarization photography of the earth's surface. To determine the distribution of the distortion over the frame field in each photographic channel, the paths through the objective were measured at 25 points uniformly arranged in the plane of the attached frame. A theodolite mounted on the attached frame measured the directions to these points in the frame field. The coordinates in mm and their distortions along the X and Y axes were calculated for the nine channels in the LKSA-3. The distortions are plotted graphically as a function of the X and Y coordinates, with the origin in the center of each frame. The errors in the determination of these coordinates was ±20 micrometers along the X axis and ±41 micrometers along the Y axis. The relevant angles, frame geometry and camera specifications are summarized in tabular form for each channel. The calibration results can be used not only to estimate the quality of the imaging, but also the quality of the fabrication of the individual camera components and to derive recommendations to eliminate deficiencies in the manufacture of such cameras. Figures 2; references: 3 Russian.
[72-8225]

UDC 551.24:629.78

DEEP STRUCTURE OF THE EARTH'S CRUST BASED ON IMAGES FROM SPACE (USING THE EXAMPLE OF REGION TO THE EAST OF THE SEA OF AZOV)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 23 Apr 80) pp 10-16

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[Abstract] The eastern shore region of the Sea of Azov has been thoroughly surveyed geologically and is a good reference test area to see how well photo interpretation of geological structures from space images correlates with ground observation data. This paper is an effort to show how the deep structure of the Precambrian basement of the Azov massif is manifest in space photographs of a regional scale and how the application of a multistage generalization technique using all available geological and geophysical data on the region can resolve certain problems in geology and metallogeny. Data from the Salyut-4, Salyut-6 and Landsat-2 were used in the compilation of a map of the structural geology of the Azov test area near Zhdanov. The deep structure of the crystalline basement is reflected in the regional photos taken from space of the territories of ancient geological plates. A major dome-like structure found in this area only

partially correlates with the geomorphological structure, i.e. is not manifest in the contemporary relief, but rather in deeper landscape indicators. This deep dome formation and other lesser structures such as the contours of local horst anticlinal uplifts of the crystalline basement, ring and arc faults in the basement, tectonic faults from the Upper Proterozoic stage of formation or activation, fractures from the Paleozoic formation stage, tectonic fault type fractures as well as belts of dikes and the geological contours of the intrusive bodies of alkaline granitoids, and ultrabasic and granitoid massifs are shown on the map and discussed in detail. This effort at the combined interpretation of space and aerial photographs with different scales drawing on standard geological data for the reference area makes it possible to understand the dynamics of the development of deep fault structures and approach the determination of the factors governing their placement within the bounds of various mineral concentrations. Figures 2; references: 16 Russian.
[25-8225]

UDC 616:629.78

UTILIZING AERIAL AND SPACE PHOTOGRAPHS TO ESTIMATE AND FORECAST ANTHROPOECOLOGICAL PROCESSES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 14 Feb 80) pp 30-39

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[Abstract] Anthropoecology is an integral part of medical geography and deals with that area of research involving the consequences of human activity; it treats the interaction between the environment and man as the processes of a single system in which the impact of the environment on man and the effect of changes in the health status of man on the environment are of equal significance in evaluating the final results. Anthropoecology includes three fields of study: 1. The investigation of the state of the natural environment; 2. The study of the health status of the populace, and 3. Searching for and substantiating the links between the state of the natural environment and the health of the populace. The possibilities for the use of satellite imaging data in the forecasting and estimation of the health status of the subjacent population is discussed. The basic problem is that of establishing the interrelationship between the environmental parameters and health status. The following data are necessary for the interpretation of space photographs: 1. The quantitative and qualitative composition of vegetation, changes in its form over time and its boundaries; 2. Surface waters, soil humidity, subsurface waters as well as snow and ice covers and ice crusts; 3. The relief, soil conditions, ground erosion and the exposure and steepness of slopes; 4. The physical boundaries of populated areas, land use within a municipality as well as unused lands and dumps, and building density; 5. The transportation roads, networks, and in

individdaal cases, the class and state of the roads; 6. Hydroelectric power generation facilities, electrical power stations, pipelines, industrial enterprises which are not associated with populated areas as well as the region where they manifest an influence; 7. Land use categories such as agricultural, tree farms and municipal parks, etc.; 8. The pollution of water and air basins, soil, snow cover and vegetation. The most important result of any successful correlation of all of these factors will be the prediction of the health status and the development of measures to improve the health of the populace. Figures 4; references 7: 6 Russian; 1 Western.
[25-8225]

UDC 528.946:629.78

INTERPRETATION OF CONTEMPORARY LANDSCAPES IN THE ALAYSKAYA VALLEY BASED ON SPACE PHOTOGRAPHS TAKEN FROM THE 'SOYUZ-22'

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 15 Feb 80) pp 40-49

BURQV, V. P. and GLUSHKO, Ye. V., Geographical Department of Moscow State University imeni M. V. Lomonosov, Moscow

[Abstract] The Alayskaya valley, which is located in the northeastern portion of the Pamir-Alayskaya mountain system in the upper reaches of the Kyzyl-Su river in the Vakhsh river basin, was photographed by the cosmonauts V. F. Bykovskiy and V. V. Aksenov from an altitude of 260 km on 18 Sep 1976 from the Soyuz-22. An MKF-6 multiple objective camera was used in six bands in the visible and infrared bands; the maximum spectral sensitivity in the narrow spectral bands was at wavelengths of 0.48, 0.54, 0.60, 0.66, 0.72 and 0.82 micrometers. The original scale was 1:2,000,000 with the spatial resolution in the center of the photographs reaching 20 m. The photographed area was 165 km by 110 km. The photographic data was interpreted and mapped using visual and photometric techniques on the multiband photographs; the working scale for the interpretation was 1:400,000, where additional data from the literature as well as field observations made in July of 1977 were also used. The composition of the tonal intensity of the black and white positives was accomplished by eye in the six bands using a seven point rating scale for the total gradations. The visual interpretation of the images was based on synthesized color photos using both natural and false color images in various combinations. The results are shown in a detailed schematic map of the landscape as well as a fragment of the overall synthesized image as seen from space. All of the relevant surface features and structures are discussed and it is noted that visual interpretation of images using these techniques makes it possible to determine the general features of the status of sown agricultural crops and vegetative cover in pasture areas as well as detect and define even such areas as eroded surfaces and locations of cattle kills. Figures 2; references 6: 5 Russian, 1 German.
[25-8225]

UDC 551.467:629.78

VARIATIONS IN THE RADIOTHERMAL EMISSION OF SEA ICE (RESULTS OF NUMERICAL MODELING)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 9 Jun 80) pp 56-63

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[Abstract] While the inadequacy of existing data on the radiothermal emission of the earth impedes the development of a correct procedure for the interpretation of measurements, sufficiently substantiated relationships have been established between the known physical, chemical and electrical characteristics of sea ice at wavelengths of from 0.8 to 8.0 cm which make it possible to formulate a numerical model for the possible variations in the microwave emission of sea ice. Empirical expressions are adduced for the electrical characteristics of sea ice at these wavelengths (the index of refraction and attenuation as a function of the bulk liquid phase content). The average seasonal temperature profiles and the salinity of both one year old and multiyear ice, as well as the density distribution in the upper layers of the latter are shown graphically and an algorithm is found for the radiothermal emission of such ices, which also takes into account surface roughness and snow cover. The integration required by the derived analytical expressions is accomplished numerically on a BESM-6 computer. The spectral curves of the radio brightness temperature of the ices for various seasons plotted as a function of temperature using the proposed algorithm exhibit good agreement with experimental data. The major variations in the radiothermal emissions of practical interest are spectral and seasonal variations, as well as those due to the thickness of the ice. These are discussed quantitatively and it is noted that the numerical modeling clears up certain features of the seasonal and spectral variations in the radio brightness temperatures. The seasonal course of the radio brightness temperature of sea ice in the case of horizontal polarization at 0.8 cm is also plotted for gray-white ice, one year old ice and multiyear ice as a function of the months of the year. The resulting radiothermal emission characteristics of drift ice can be used in conjunction with other experimental data to develop a technique for the interpretation of remote sensing data in the microwave band. Figures 4; references 19: 15 Russian, 4 Western.
[25-8225]

UDC 551.46:528.7

INFLUENCE OF THE ATMOSPHERE AND OBSERVATION WINDOW OF A SPACECRAFT ON THE CONTRASTS OF NATURAL FORMATIONS VISIBLE FROM SPACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 15 Apr 80) pp 64-70

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[Abstract] When natural ground formations are observed from space, the frequency-contrast characteristic of the intervening medium is more significant than the phase-contrast response, since the former allows for the derivation of a simple estimate of the impact of the intervening media: the atmosphere and the observation window. The frequency-contrast characteristic of the overall system is equal to the product of the corresponding characteristics of its components. This paper analyzes the transfer functions of the atmosphere and the observation windows of spacecraft in the visible spectrum based on definitions of the frequency-contrast response. The threshold values of contrasts which can be visually observed, photographed or recorded with TV equipment from space are directly related to the transmittance functions of the atmosphere and observation windows. Data is presented in tabular form for the transmittance of a cloudless atmosphere in the visible spectrum for the case of observations from space at the nadir of the earth's surface at middle latitudes, the brightness of a cloudless atmosphere for observations from space at the nadir as a function of the angle relative to the sun as well as estimates of the background radiation brightness of the solar observation window and one oriented towards the earth in the Salyut-6 station in the twilight zone. The analysis of observation threshold levels shows that the most expedient approach to the study of natural resources from space is the use of visual observation in conjunction with photography, while for objects with sufficient contrast, TV can be employed. The prospects for the development of optical methods for studying the natural environment from space are closely linked to both the development of more sophisticated optical equipment and the efficient choice of experimental conditions. Figures 1; refernnces: 4 Russian.
[25-8225]

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DIRECT METHOD FOR THE CALCULATION OF INFRARED RADIATION TRANSMITTANCE FUNCTIONS BY WATER VAPOR IN AN INHOMOGENEOUS ATMOSPHERE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 31 Mar 80) pp 71-77

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[Abstract] The importance of studying the transmittance function for the water vapor bands in the atmosphere is not only related to the remote sensing of the atmosphere, but also the fact that water vapor radiative transport is one of the

major components of the atmosphere's radiation balance. While the most precise and flexible approach to the calculation of transmittance functions in the IR portion of the spectrum is the line-by-line technique, it requires large expenditures of computer time. Previous line-by-line computational algorithms for such functions have had the common features of: 1. The use of detailed spectroscopic data; 2. The entire atmosphere is broken down into n plane-parallel homogeneous layers; 3. The choice of an integration step which permits a detailed description of the frequency function of the optical thicknesses. It is possible to determine the nature of radiation absorption both in the water vapor bands and transmittance windows where the "wings" of strong rotational band lines play a significant part as well as those of vibrational rotational bands. The notion of the "wing" contribution introduced by R. Drayson [University of Michigan, Tech. Rep. 7584-1-T, Nov 1976] substantially curtails the amount of calculations, but the integration step is still constant and does not consider the fact that the half-width of a line changes considerably with altitude, so that the constant step creates errors or requires large amounts of machine time. Accuracy is further compromised through the use of the same half-width for all lines. This paper proposes a technique for the line-by-line computation of transmittance functions which generalizes all previous procedures and circumvents these deficiencies. The expressions derived for the water vapor transmittance functions for both homogeneous and inhomogeneous paths are checked against experimental data for the 6.3 micrometer band, where the pressure, temperature and concentration parameters changed practically throughout the entire possible range of values for the lower layers of the atmosphere. The divergence between the experimental and calculated data falls in the range of experimental error, i.e., does not exceed 3 to 5%. The greatest systematic disparities between calculated and experimental data fall in a range of 1,600 cm^{-1}, which is apparently explained either by the inaccuracy of the original spectroscopic data or the divergence between the shape of the actual equipment function and the theoretical. About one hour of machine time on a YeS-1022 computer is needed for the water vapor transmittance functions for an inhomogeneous atmosphere in a spectral range of 1300 cm^{-1} to 2000 cm^{-1}, where the integration covers altitudes up to 30 km. Figures 5; references 11: 6 Russian; 5 Western.
[25-8225]

UDC 535.24

CHOICE OF BANDWIDTH OF THE VIDEO CHANNEL OF REMOTE SENSING OPTOELECTRONIC SCANNING EQUIPMENT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 26 May 80) pp 87-91

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[Abstract] The quantitative relationships between the scanning rate and video channel bandwidth on one hand, and the spatial equipment function which describes the image quality from the viewpoint of spatial resolution as well as the signal

to noise ratio of the optoelectronic scanner on the other are determined. Analytical expressions are derived for the video channel frequency response and the spatial equipment function. The bandwidth and the s/n ratio are also found from considerations of the energy requirements of remove sensing scanners and the assumption that the photon noise is greater than the internal receiver noise. The analysis shows that where detector noise predominates, the video bandwidth influences both the spatial equipment function and the s/n ratio, but where the photon noise from the radiation source predominates, the video bandwidth influences only the spatial transmission function. A gain is observed in the s/n ratio of a scanner which is proportional to the square root of the decrease of the effective bandwidth where the internal thermal noise of the receiver is greater than the photon noise. The purely theoretical treatment of this paper adduces no sample calculations or experimental checks. Figures 3; references 4: 2 Russian; 2 Western.
[25-8225]

UDC 528.72

PRINCIPLES OF DELTA MODULATION PROCESSING OF MULTIBAND VIDEO DATA FOR REMOTE SENSING OF THE EARTH

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 19 Mar 80) pp 92-103

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[Abstract] The major requirement placed on the processing of multiband video data from the remote sensing of the earth for the purpose of user inspection of large data files and the visualization of certain features is the real time execution of the operations. Delta modulation is the appropriate tool for the digital processing of video information and the timely interpretation of remote sensing data, because of the analogy existing between difference algorithms and delta modulation. Difference computational schemes are applied to delta modulation space invariant and scale transformations of the imaging data. The computer modeling techniques are illustrated with a typical remote sensing example: element by element subtraction of two images from channels nos. 5 and 6 of the multispectrum scanner of the Landsat-1. The steps in the image transformation are discussed and shown pictographically, with the result that nonlinear geometric distortions are considerably reduced although the final visualization does not have a high brightness resolution (16 gradations of brightness on the alphanumeric printer). Schemes for high speed microprocessor controlled image processing as well as the control microprocessor configuration are discussed; the INTEL 8080 and Z 80 microprocessors are the preferred choices. The delta modulation systems operates in real time with an average quality of less than 8 bits/image element and is free of the drawbacks inherent in PCM systems due to the considerable equipment requirements and poor speed. The proposed techniques have been under study for several years at the Central Space Research Laboratory of the Bulgarian

Academy of Sciences within the framework of the research program for delta modulation applications to ground and satellite remote sensing systems. Figures 10; references 11: 7 Russian, 4 Western.
[25-8225]

UDC 629.19:551

LAWS GOVERNING THE CHOICE OF THE DESIGN PARAMETERS OF A SPACEBORNE SURVEY SYSTEM FOR EARTH STUDY

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80 (manuscript received 25 Mar 80) pp 104-108

AVDUYEVSKIY, V. S., SAUL'SKIY, V. K. and USPENSKIY, G. R.

[Abstract] Setting more stringent requirements for the details visible in satellite photographs leads to a reduction in the rate at which the photos must be made. This means that to satisfy the future needs of the national economy, it is economically expedient to utilize different types of spaceborne facilities, differing primarily in their resolving power and scanning period. An important problem is the efficient choice of the composition and the design parameters of future observation satellites treated as a unified whole. This paper proposes a methodological approach to this problem, using the following formulation: 1. The aggregate of earth observation missions corresponds to a set of points in a system of coordinates specified by the major requirements placed on the data: the terrain resolution and the survey periodicity; 2. Any spaceborne equipment complex in this system is depicted as a right angle formed by lines parallel to its axes and diverging from a point, the coordinates of which are the resolution and observation periodicity required and which are directed towards decreasing stringency of these requirements; 3. Each survey problem is considered solved if the point corresponding to it falls on even one of the angles representing the space equipment complexes; 4. The best choice is that which fully solves the specified set of observation problems at the minimum cost. The mathematical treatment generates the criteria for maximizing system performance with minimum cost. The technique is illustrated with a sample calculation where the terrain resolutions varies from 2 m to several km and the survey period ranges from 0.1 day to several years; the resulting space system should consist of three different sets of equipment. Figures 2; references: 1 Russian.
[25-8225]

UDC 551.46.0:629.78

EXPERIENCE WITH SATELLITE OCEANOGRAPHIC RESEARCH IN THE UNITED STATES. I. SEASAT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 80
(manuscript received 14 Feb 80) pp 109-116

KONDRAT'YEV, K. Ya.

[Abstract] The equipment complement of the Seasat satellite launched 28 Jun 1978 which failed 10 October 1978 included five instruments (in order of their priority): a radio altimeter, a scatterometer, a synthesized aperture radar (a side-looking radar), a radiometer for the visible and infrared bands and a multichannel scanning microwave radiometer. A discussion of the technical specifications and capabilities of all of these instruments is followed by a review of the programs implemented during the life of the satellite. Graphs are plotted showing the correlation between wind velocity and direction derived from scatterometer data and direct buoy measurements as well as the results of wind velocity measurements from data of the multichannel radiometer and direct measurements. The results of the determination of the ocean surface temperature over three orbits are also shown graphically as a function of latitude. The summary of satellite performance focuses primarily on the precision of the data as evidenced by correlation data from ground sources. In summing up the preliminary analysis of the Seasat data, the conclusion is drawn that the experience with the operation of remote sensing equipment for oceanographic studies installed in the Seasat satellite is positive and opens up broad prospects for the development of satellite oceanography. Figures 3; References 11: 2 Russian; 11 Western.
[25-8225]

LIFE SCIENCES

ACADEMICIAN GAZENKO INTERVIEWED ON MEDICAL ISSUES IN MANNED SPACEFLIGHT

Moscow NEDELYA in Russian No 45, 1980 pp 10-11

[Interview with Academician Oleg Georgiyevich Gazenko by Yevgeniya Al'bats]

[Text] Scientists first obtained data on the effect of space on a living organism in November 1957. Four years later, when the "Vostok" became the first manned spacecraft to go into orbit, a new field of science was born: space medicine. Since that time, 98 cosmonauts have gone beyond the Earth's boundaries. The 185-day flight of Leonid Popov and Valeriy Ryumin proved again that man can live and work in space for a long time. However, this in no way means that all the problems are behind us. The scientists still must solve a multitude of scientific and technical problems.

[Question] Oleg Georgiyevich, now that Valeriy Ryumin has spent almost a year in orbit as the result of his two flights, can we speak of some limit to man's ability to function in space?

[Answer] Is there, in general, any limit to man's capabilities? Not to his intelligence, his dreams or his aspirations, as far as we know. But if the answer is "yes," then our civilization must some day stand before a threshold we will not be able to cross. And we will forever remain bound within limits -- vastly spacious ones, perhaps, but still limits that are determined by the dimensions of our planet. Will we be able to reconcile ourselves to this? Therefore, I think that in the future, people will live and work in space for an unlimited length of time.

When will this be? I don't know, but apparently not soon. In any case, the final answer can be given only after man's entire life cycle -- including a change of generations -- takes place in space. Only then will we have the right to say that man has completely mastered outer space and crossed the ultimate boundary. For the present he is only a temporary visitor, a guest.

However, if we take a narrower view of this question and talk about the possibility of remaining in orbit for a year or a year and a half, then it seems to me that here we can see no theoretical limitations. All the same, it would be better to speak guardedly, since all projects related to spaceflight must be carried out while observing an absolutely immutable principle: safety and maximum reliability. In the future, increases in the duration of flights--- and this is a very complex matter -- will be successive and gradual.

/Question/ The specialists think that from the engineering viewpoint, there are no longer any serious, unsolvable problems preventing a flight to, let us say, Mars. The basic factor holding us back is man himself or, more probably, his psychological and physiological nature, which, nevertheless, with some effort can establish "diplomatic" relations with weightlessness. Therefore, please tell us about the problems that are now the most urgent ones for space medicine.

/Answer/ There are a lot of them. Don't forget: we are still at the very beginning of the path into space. At the same time that investigations in orbit increase our knowledge, they also raise a whole series of new questions. For example, we still have much to find out about the effect of weightlessness on the nature of metabolic processes and cell division and we still don't know the mechanism of the reactions that lead to the loss of calcium -- the basic building material for the bone -- from the body. That is, in principle we are guessing how to deal with this, but we have not yet come up with any specific methods.

Changes in the blood also continue to disturb us: when affected by weightlessness the volume of circulating blood is reduced; this means, in particular, a reduction in the number of erythrocytes, which are responsible for transporting oxygen to the tissues. About a month and a half after returning to Earth everything is stabilized and back to normal, but it would be desirable to be able to avoid such aftereffects.

And yet more. As the duration of a flight increases, there is also a danger of lowering the body's resistance to infections. Fortunately, none of our cosmonauts has yet gotten sick in orbit, but since the problem does exist we must investigate it so thoroughly as in principle to eliminate the danger of disease. It is a well known fact, for example, that man lives in symbiosis with a huge number of microorganisms. Among them, the overwhelming majority are the so-called saprophytes -- beneficial microbes. However, in space they occasionally lose their friendly disposition toward us and can cause, let us say, an allergic reaction. Why? How do we prevent this? And there are many questions like this.

/Question/ In an interview you gave NEDELYA last year, you said that a further increase in the amount of time man can function in orbit will also require an improvement in the system for the medical monitoring of the cosmonauts' health. With respect to this, have there been any changes?

/Answer/ On the last flight, I chose experiments that were directly related to a study of the functional features of the cardiovascular system, which, for understandable reasons, disturb us most of all. For example, the results obtained with the help of the programmed-dynamic electrocardiography method are enabling us to determine the body's reserve capabilities and direct the individual modes of physical training for the cosmonauts to a qualitatively higher level. The experimental technique is quite simple: with the help of a miniaturized tape recorder carried on the body, the smallest deviations in the heart's functioning during physical training are recorded.

By the ballistic cardiography method, which was also used for the first time on this flight, we conducted a systematic investigation of the heart's contractive function and obtained new information on individual reactions of the blood circulation system to weightless conditions.

On the whole, the series of extended flights has shown that we are on the right track, in principle, to the solution of the basic problem, which is preserving the good health of cosmonauts and maintaining the high efficiency of their work.

/Question/ Medicine now has the ability to observe people who have been in space for extended lengths of time for several years after completion of a flight. Does this give us grounds for saying that space does not cause changes in the body?

/Answer/ I would not venture to say that flights into space do not leave any traces. But even on Earth, every day something in us changes in comparison with the preceding day: tomorrow we will no longer be what we are today, and today we are not what we were yesterday. And we don't do anything to cause this: life is a dynamic process. How much these traces are justified by the goals that have been formulated and how dangerous they are for man is another question.

Observations of cosmonauts have not revealed any serious changes that could be attributed to a protracted stay in space. However, there is a certain amount of difficulty involved in solving the fundamental aspect of this problem: we are dealing with men and, therefore, must investigate them with particular care. For example, it is not known whether or not there is any rearrangement of the lungs' vascular canal as the result of their overenrichment with blood under conditions of weightlessness. And does this effect remain or not? As yet, we can form an opinion on this matter only on the basis of some functional and indirect indicators, but not directly. And as doctors, we must naturally be interested in accurate data.

Since the amount of knowledge we have is still not as great as we would like, we have not yet discovered all the secrets of weightlessness. However, we allow ourselves to move forward as long as we are confident that we are working in an area where there can be no misfortunes involving men.

/Question/ The American scientist David Vinter says that the health requirements for cosmonaut candidates can be lowered and recommends more boldness in sending women into space. Do you share this point of view?

/Answer/ Well, you see, what Doctor Vinter said concerns relatively brief flights of, let us say, a week or maybe a month. I also think that such intervals of time are allowable for a broad circle of people who are "practically healthy." However, I am absolutely not certain that everyone will be able to work effectively in space. If that be the case, however, a flight itself makes no sense. It only seems to be the case that everything is easy in weightlessness.

/Question/ Is it possible to predict the reaction of one cosmonaut or another to weightlessness while he is still on Earth?

/Answer/ In principle, it is. To be honest, however, we still do not know how to do this reliably and in some cases we have been mistaken. This is because on Earth we cannot simulate the entire complex of conditions that a man meets in orbit.

Incidentally, this also applies to a whole series of different problems: it would always be easier to carry out on Earth experiments with effects that cover what can be expected in space and then proceed with a flight. In this we are still not successful, however, and each new extended expedition is to some degree a step into the unknown.

/Question/ Does that mean that there will always be a certain degree of risk?

/Answer/ Naturally. However, the increase in the duration of flights into space is not happening spontaneously, but on the basis of previously accumulated data that enable us to make an approximate prediction of the possible extension of the amount of time man can spend in orbit. In addition, during a flight this prediction is corrected on the basis of the continuous collection of information on a cosmonaut's current state of health and the formulation of a prediction for each successive week. If some danger signals appear we can bring the flight to an end so as not to place a man in a situation that is capable of causing serious damage to his health.

/Question/ Oleg Georgiyevich, at the dawn of the space era did you think that weightless would be such a nuisance?

/Answer/ At that time there were two attitudes toward this matter. Almost all the conclusions had been reached on the basis of theoretical research, since there were very little experimental data. Therefore, the predictions were, for the most part, on the pessimistic side. The first experiments using rockets and then artificial Earth satellites with different biological objects produced positive results and raised our hopes. The pessimism was then replaced, I would say, by extreme optimism: when man flew into space, it became obvious that there were still very very many problems to be solved.

The question immediately arose: is it necessary to help man adapt to space or should we let the matter follow the natural course of events? Further research demonstrated that for brief flights there is no special need for taking any measures: man will return to Earth without having had time to adapt away from the conditions of his natural home.

Everything changes when a cosmonaut has to function for a month or longer. Here the rearrangement of functions goes so far that under conditons of weightlessness a man can live and work quite freely without meeting any serious impediments. But then the return to Earth becomes a problem. It is difficult for the cosmonaut to walk, his sense of equilibrium is quite poor, and his coordination is disrupted. In brief, when we set as our goal increasing the amount of time man can stay in outer space, we immediately must think not only of how to adapt him to the factors of weightlessness, but also how he will then be able to exist normally on Earth. The difficulty of readaptation increases with the length of a flight.

/Question/ But Leonid Popov and Valeriy Ryumin remained in space for 185 days -- longer than anyone before them. And right after they landed they were active, and in [illegible] hours they were already walking in a park. Moreover, while in orbit they put on weight, which is something out of the ordinary in the history of extended spaceflights. How can you explain this?

/Answer/ I think that the good state of their health is in large part because of the cosmonauts themselves. By way of demonstration, let me give you some figures: every day on the veloergometer they "traveled" 10-12 kilometers, while also covering about [illegible] kilometers on the running track. The result, as they say, speaks for itself: for the first time after an extended flight we did not detect any decrease in the strength of the calf muscles, which on Earth help man to maintain an upright position.

Actually, Valeriy Ryumin is now a professor of weightlessness. By his own experimenting, he convinced himself of the effectiveness of the recommendations made by the doctors. In addition to this, some elements of our program were corrected by Ryumin himself, in conformity with the needs of his own body. Such a creative approach is very important: our recommendations were designed for an average person and it is necessary to improve them not only in theoretical situations, but also in their practical realization. As far as Leonid Popov is concerned, his comrade's experience obviously helped him very much.

But I do not share the optimum caused by the fact that the cosmonauts gained weight. In my opinion, it would have been far more desirable if they had returned to Earth weighing the same as when they left, having neither gained nor lost weight. It's nice, of course, that they maintained good appetites throughout the entire flight, because this is a very important indicator. But, on the other hand, there must always be the correct relationship between the expenditure of energy and the intake of those materials that are used for the body's plastic and energy needs. If this balance is disrupted, a man takes on excess fat, and what the final result of this is we know quite well on Earth. The 3,100 calories the cosmonauts received were apparently slightly more than their bodies expended in physical exercise. I don't know, though, whether or not Valeriy set for himself the goal of gaining weight.

/Question/ It seems that some terrestrial problems are also acute for cosmonauts.

/Answer/ Precisely. Incidentally, this analogy can also be used with respect to the heart. A famous cardiologist once said that for people in today's civilization the presence of "the heart of an active loafer" is characteristic. Judge for yourself: we ride to work, at home we use an elevator, we spend our day behind a desk, and we frequently forget entirely about our regimen and athletic activity. As a result, we take care of a number of different useful matters but our hearts are transformed into an unusual loafer. Approximately the same thing can happen in orbit if cosmonauts do not do physical exercise.

Therefore, in order to avoid problems, a whole system of prophylactic measures has been prescribed for cosmonauts to help keep their hearts normal. By the way, during the entire flight no disruption of the heart's rhythm or any other serious changes were detected on the part of either Popov or Ryumin.

/Question/ How important are specific bodily features for functioning in space? Is this a matter of any fundamental importance?

/Answer/ I don't think so. Weightlessness affects all cosmonauts, without exception. But the extent of the manifestation of reactions is different and depends, of course, on the individual physiological characteristics of the body. Let us say that Valeriy Ryumin belongs to that small group of people (about one-third of all those who have flown in space) who adapt to weightlessness quite easily. However, this is a subjective ease, and the objective indicators say that in this group there occur the same changes in, for example, the activity of the cardiovascular system and the water and salt exchange process as occur in the others.

/Question/ In your statements you have more than once thanked the cosmonauts for the courage they exhibited during a flight. What, in your opinion, is the most difficult factor in working in orbit?

[Answer] The constant overcoming of oneself. The impossibility of relaxing for a single moment. Living from hour to hour. And the mass of other moments that are related to professional risks.

[Question] The last question is from the field of fantasy. Arthur Clarke writes that in the near future weightlessness will become the normal state of man, and that our descendants will be as indifferent to the force of gravity as our remote ancestors who swam in the sea without any special effort. What do you think?

[Answer] Man is a creature of Earth. Over the course of many centuries special physiological mechanisms that enable him to deal with gravity have evolved in his body. He has a more or less strong skeleton that is capable of counteracting the force of terrestrial attraction, nervous devices that enable him to stand on two legs, valves in his veins (on our planet, blood also has weight), and -- finally -- a thorax that even without functioning of the heart insures the pumping of blood to the upper part of the body. All of this was designed wisely by nature itself, and for us it is absolutely not a matter of indifference whether gravity is present or not; therefore, in space, also, it is necessary to create for man those conditions that do not contradict his biological "ego."

In this case, will man become a creature of space?

Yes, he will. Not because of changes in his physiological mechanism, but because of his intelligence.

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EFFECTS OF WEIGHTLESSNESS IN LONG SPACEFLIGHTS

Kiev POD ZNAMENEM LENINIZMA in Russian No 23, Dec 80 pp 65-68

[Article: "Man Under Conditions of Weightlessness"]

[Text] In recent years, the Soviet Union has actively set about the operation of orbital stations, which comrade L.I. Brezhnev called the decisive tool for the widescale mastery of outer space. Several months of duty by the cosmonauts in them have become an everyday phenomenon. The research performed by the crews on-board such stations is having an enormous scientific and economic impact.

Great service has been done by the specialists in space medicine in the achievements of manned space flights, who have done everything so that the cosmonauts can work long and fruitfully in orbit. A group of Soviet scientists have been awarded the State Prize of the USSR for the development of methods and means which prevent the unfavorable influence of long term weightlessness on the human organism as well as their practical implementation in space flights.

Doctor of medical sciences and winner of the State Prize of the USSR, Igor' Dimitriyevich Pestov, discussed the problems related to life support and the activity of cosmonauts in long space flights.

In setting on an orbital flight, man not only rises several hundreds of kilometers above the planet, he breaks with the conditions under which he was formed and constantly lives. The new medium, which he penetrated 20 years ago is unique and foreign to his nature. The absence of gravity imparts the uniqueness to it - a factor which is quite important for everything living and growing on the earth. For this reason, man has started very cautiously in mastering space, a world without gravity. The first explorers in orbit were various biological objects, including our four-legged assistants.

The biological studies make it possible to establish a fact of fundamental importance: a living organism can exist in weightlessness. The conclusion that a short stay by man in space would not be accompanied by a disruption of the vitally functions of his organism followed from this.

True, studies on animals could not answer the question of how flignt conditions would effect the behavior and higher nervous activity of man. Warnings were voiced that under the extreme conditions of spaceflight, the intellectual activity of man would be difficult, and when breathing, taking in water and food in weightlessnesss, he would encounter serious difficulties.

Now, it is possible that these warnings seem naive. But as applied to that level of knowledge with which the study of weightlessness and the influence of other factors of spaceflight began, the increased caution was altogether justified and forced a careful weighing of everything "for" and "against".

For this reason, medical personnel monitored the flight of Yu.A. Gagarin and then G.S. Titov with special attention. And these flights provided much valuable scientific information.

The first real obstacle which cosmonauts encountered in the flight was vestibular disturbances which were accompanied by motion sickness and illusions concerning the spatial position of the body.

During flights along a parabolic trajectory in an aircraft, where short term weightlessness (up to 40 seconds) is replaced by overloads, such distrurbances were not surprising - to a certain extent, this is reminescent of an enormous swing: man, just like a chip of wood on a wave, is lifted up and then thrown down. It was not understood why such phenomena were observed in orbit where there was no kind of swinging motion.

Various hypotheses were put forward, including the following. The otolithic membranes of the vestibular apparatus when deprived of weight became a unique kind of "negative stimulus" for nerve formations on which they exerted a constant pressure under ground conditions. Simultaneously, the sensitivity of the vestibular apparatus to rotations of the head was increased. The position of the body in space was determined only by means of vision. And with the eyes closed, not feeling the weight of his body, and not receiving signals from the receptors of the muscles, joints and skin, man lost his orientation and was not capable of determining the position of the body. The chaos in the sensations generated the illusion of rolling over and head spinning. This provoked the development of rotion sickness. In the initial phase of spaceflight, as it turned out, every third cosmonaut experienced such disturbances.

But it is important to note yet one additional curious fact: the correlation between the susceptibility of man to motion sickness on the earth and the probability of the occurrence of vestibular disturbances in spaceflight did not prove to be reliable. A man can experience motion sickness on the ground and feel well in space. And vice-versa.

A probable cause for the lack of such a correlation can be the fact that the way cosmonauts feel in the initial stage of space flight is complicated by the extraordinarily unpleasant sensation of the rush of blood to the head, which can be manifest in various people to varying degrees. Consequently, this specific mechanism can also participate in the development of vestibular disturbances in spaceflight. To overcome these disturbances, a system of preflight training of the vestibular apparatus, as well as training exercises for the "antiorthostatic" position of the body (that is, for the position in which the head is located below the legs) is being employed with a certain degree of success. Nonetheless, this problem still cannot be considered completely solved.

Fortunately, vestibular disturbances in spaceflights are of a temporary nature and last, as a rule, for two to three days, rarely longer. And then they go away. They are now treated as a hard reality and no longer cause the previous worry. Although research is going ahead in this direction as before.

In step with the increasing duration of spaceflights, the number of problems which confront specialists has also increased. It has turned out that the vestibular disturbances are only part of the response of the organism to the unusual conditions of the world without gravity.

Now, 20 years after the flight of Yu.A. Gagarin, the mechanism for the influence of weightlessness on the major systems of the human organism has been ascertained to an adequate degree. However, the questions concerning the possible impact of weightlessness on a cell, the apparatus of heredity and intimate processes of life activity require further study.

The following expression can be found in popular scientific articles: "Weightlessness is enemy number one". Man has more than enough enemies in space. These are also radiation, vacuum and the enormous temperature gradients. But the expression is true in the sense that as compared to the other factors of space flight, weightlessness provides living organisms with the greatest discomfort and additionally seriously complicates the prevention of unfavorable consequences for the organisms.

Hermetically sealed rooms and space suits can reliably protect man against the vacuum of outer space. Ways of protecting him against radiation and the danger of meteors are also known. The problem is much more complicated in the case of weightlessness. It is completely out of the ordinary and unique in terms of its effect on the organism,and you cannot put up any kind of shields against it.

It would seem that in space the organism enters exceptionally favorable conditions: here it is freed from all of the difficulties related to the earth's gravity. But as it turns out, not every easing of conditions is a good thing.

Weightlessness means of a reduction of the muscular loading, a reduction in the load on the skeleton and the absence of hydrostatic blood pressure.

As a result of the removal of hydrostatic blood pressure, for example, there is an overfilling of the vessels of the upper portion of the body. This is accompanied by a sensation of heaviness in the head, headaches and illusions of rotation below the head. The influxes of blood, as was stated above, promote motion sickness and the activation of vestibular disturbances.

If things continued like this all the time, manned flights into space would be impossible. But in response to the unusual conditions, the organism actuates adaptive mechanisms. Receptors in one of the auricles of the heart react to the excess of blood in the upper half of the body. The signal from them is fed to the hypophysis. The latter slows down the output of the antidiuretic hormone. The kidneys are activated and eliminate fluid from the organism. The volume of blood is curtailed because of this. The overfilling of the upper part of the body with blood is eliminated, and the influxes to the head are felt to a lesser extent.

The coordination of the movements of a man in weightlessness is also disrupted. When we extend an arm under ground conditions to take something, the correction for its weight is taken into account in the motion of the arm. In space, attempting to make the same motion, a cosmonaut misses the mark, reaches above the target since the previous habit is in force. Seeing his mistake, he begins to make the correction. Vision assists him in this. The new habit is formed rather rapidly. And the old one is forgotten. And this becomes more so, the longer the flight lasts. When he returns to earth, the cosmonauts must again reteach himself.

Nature is a genius at design. In the human organism, it has provided for reserves, given thought to the duplication of a number of functions and embodied in it the capability of substituting for lost properties, increasing the reserves and reliability by means of training exercises. But nature is not extravagant; she does not strive for excessive solutions.

The reduction of the muscular load and the reduction of the load on the skeletal support apparatus as well as the removal of hydrostatic pressure do not occur without consequences for the organism. It is threatened by atrophy from inactivity and a lack of use.

As soon as the load on the skeleton is reduced, calcium begins to leach out of the bones, and they lose their strength. If there is no load on the musculature which opposes the force of gravity, the muscles decrease in volume. Since no stress is placed on the cardiovascular system related to constantly supporting the energy status of the organism with oxygen and nutrients to counter the earth's gravity, a lack of cardiac muscle tone develops and the heart performance is reduced. Changes occur in the exchange processes. It is apparent that one could reconcile onself to this if man did not return to earth sooner or later and the readjustments of his organism did not go too far and threaten his health.

But man cannot stay in space forever. And the encounter with the overloads during landing and the earth's gravity do not bode well for a weakened organism.

Any biological system possesses adaptivity - the capability of accomodating changes in the ambient conditions. The environment, if we turn to the terminology adopted in cybernetics, is the vehicle which organizes, shapes and controls the information for the organism. This information is fed into the organism in the form of weight loading, stresses and deformations which it experiences when exposed to gravity. The constant influx of such information forces the organism to react to it, to come up with some new qualities or properties.

When such information is absent, phenomena occur which are called entropic shifts in cybernetics and information theory, because of which, the uncontrolled system tends to reduce the level of its own organization, tending to decay and chaos.

As applied to biological systems, the force of gravity is a formative and creative element. And weightlessness means its absence. of this, the changes in an organism in space go in the direction of expending previously acquired properties and qualities which assist it in countering the load.

For this reason, weightlessness is the cause of entropic shifts in an organism. The system of artificial control actions must counter its unfavorable impact. In other words, man in space needs some kind of loads equivalent to those to which his organism is accustomed on earth. This is the only way of combatting the consequences of weightlessness.

How is an equivalent of a weight load to be produced in outer space if nothing weighs anything there and man freely floats in the compartments of the orbital station?

K.E. Tsiolkovskiy gave some thought to this early on. He proposed that this be done by means of an artificial gravity. If a spacecraft is rotated, then a load appears by virtue of the radial acceleration which is close in terms of its nature and effect on the organism to the earth's gravity.

It is true that serious difficulties are encountered here. Thus, so that the artificial gravity produced by rotation does not cause vestibular disturbances, the space system should have a large radius of rotation - tens and hundreds of meters. This substantially complicates the structural design of the system.

Moreover, life in a constantly rotating station involves no few difficulties related to the appearance of so-called Coriolis accelerations when people move about. The perforance of research, experiments and observations in weightlessness would be impossible in this case.

Since the set of hardware for preventing the unfavorable effect of weightlessness which has been developed at the present time satisfies the practical requirements of space flight, the question of creating an artificial gravity in spacecraft is premature. The basis for the existing set of prophylactic tools is the effort to create an equivalent weight load in weightlessness on the skeletal and muscular apparatus and to eliminate the consequences of the unusual distribution of blood in the organism, something which is related to the absence of its weight and hydrostatic pressure.

A constant static load can be created on the muscles and skeleton by means of rubber pull ties, run along the body. The G-suits which cosmonauts now use in flight operate on this principle.

A complex training device with a "running track" makes it possible to obtain a dynamic physical load in the station. The cosmonaut, suited up in the load suit gets on the "running track" and is secured to it by means of a tie-down system. As a result, the suit distributes the forces on the waist and shoulders, while the legs are pressed against the track by the force. This makes it possible to walk, run and jump with a considerable expenditure of physical force, maintaining the coordination of the most important motor skills.

Another type of space trainer is a bicycle ergometer, by means of which the physical load can be apportioned in a wide range, preventing the development of loss of muscle tone, including that of the cardiovascular system.

To simulate the intravascular hydrostatic pressure of the blood, installations are used which reproduce a reduced pressure in the lower half of the body and promote the travel of blood to the legs.

Also included in the arsenal of prophylactic tools are instruments for electrically stimulating the muscles, water-salt loads and pharmacological preparations.

The efficient organization of labor, rest and everyday life of the cosmonauts plays an important part in the prevention of unfavorable consequences of long-term space flights.

All this has on the whole made it possible to extend the scope of the permissible duration of spaceflights and gradually bring them up to their present day periods. And they, as is well known, are now figured at many months.

In the long term, the time periods which have been achieved will probably prove to be inadequate. Manned flights to investigate the planets can last for years. The work of crews in stations orbiting the Moon, Venus, Mars and Jupiter can be just as lengthy. What are the forecasts as regards flights of this duration?

They can be based on the generalization of the previous experience, an analysis of the trends and a study of analogs. Experience with the manned flights which have been made with a duration of up to half a year give evidence that besides the well-known phenomena of a rapid adaptation to weightlessnes and the development of asthenization processes related to the phenomena of "lack of use" or "atrophy from inactivity", no other unexpected or qualitatively new changes will occur in the human organism. It stands to reason that if corrective and control measures are not taken as regards these changes, they can reach dangerous levels for health and in particular, seriously complicate the process of readaptation or acclimatization to ground conditions following the completion of the space mission. But with the appropriate execution of the planned volume of prophylactic measures as well as the observation of the work and rest routine, long term flights will go no worse than flights of short duration.

A stable equilibrium status has been achieved with respect to the majority of functional indicators for the cardiovascular system, blood production, metabolism and the support and muscular apparatus, something which does not provide the basis for presupposing the appearance of unexpected and unfavorable trends with a subsequent increase in the duration of space flights. Apparently, psychological difficulties will take on the greatest significance, although they do not appear to be insuperable.

Moreover, illnesses, the probability of which during a long flight can increase because of asthenization and the reduction of the resistance of the organism, the demineralization of bone tissue, which is related to the slow but constant losses of calcium by the organism can become factors which limit the duration of space flight. Although physical loading is capable of retarding the rate of calcium lost, the danger exists that under conditions of weightlessness, the demineralization of bone tissue can become the reason for a reduction in the strength of the skeleton, and one can also presuppose that the hypodynamia which constantly and unavoidably accompanies weightlessness will serve as the precondition for the development of premature aging.

Taking the reservations stated above into account, it can be said that flights from one year to several years in length are possible in principle, but require the incorporation of medical personnel into the crew, and special equipment on the ship for diagnostic, treatment and prophylactic assistance. It is also essential to implement a broad set of measures which facilitate the readaptation of the organism to ground conditions following the completion of such flights.

Long-term bed confinement, as is well known, can serve as an analog of long term weightlessness. The results of physiological and clinical observations do not refute in principle the real possibility of long-term manned flights, but additionally point out the importance of medical and preventive care during the mission as well as the implementation of medical and restorative measures during the readaptation period.

The reversibility of the functional and structural realignments, due to the impact of long term weightlessness on the organism is the most important criterion for establishing the permissible length of missions. K.E. Tsiolkovskiy wrote early on that in weightlessness, the legs will lose their importance, cease their existance and change into appendages which are in no way useful and are unnecessary to the organism.

It is now premature to forecast such changes. But the symptoms of this kind of rearrangement exist.

If the strength and volume of the muscles of the arms and legs of cosmonauts are compared before and after a long mission, it is easy to note that the arms have lost nothing, and even more, have at times increased their strength. As far as the lower extremities are concerned though, here the dystrophic changes are apparent: the legs have grown thin and their bones have become less dense.

On the other hand, for the fully formed organism of an adult man, the restoration of the structure and function, judging from the results of space missions which have been performed, takes place successfully, although a certain amount of time is taken for this. Less clear is the answer to the question of what the reversibility would be for the losses due to weightlessness in space for a young developing organism, in which the formative role of gravity could not be manifest to the same extent that it would be for his counterparts of the same age on earth. It can hypothesized that the process of development in this case would run its course with deviations as compared to the ground standards and could be locked into the specific features of his structure and functions, something which would complicate the subsequent process of adaptation of the young organism to ground conditions. And although this question is of only theoretical significance at the present time, it should probably be studied in research on animals as applied to the prospects for the expansion of spaceflight.

In the period which has elapsed since the time of the historic flight of Yu.A. Gagarin, Soviet space medicine has accumulated considerable experience, has enriched science with factual data and theoretical findings, and has made a remarkable contribution to the development of domestic spaceflights. The scientific and engineering progress which was spawned by these requirements will in the future carry out its high humanitarian mission, contributing to further successes in man's mastery of outer space.

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CSO: 1866/66

SPACE FLIGHT DIET

Moscow SOVIET MILITARY REVIEW in English No 6, Jun 80 pp 38-39

[Interview with I. Popov, candidate of medical sciences: "Space Flight Diet"]

> [Text] One of the conditions ensuring preservation of health and capacity for work in space flight is a correct diet. A SOVIET MILITARY REVIEW correspondent was granted an interview by I. Popov, candidate of medical sciences, an expert in space dietetics.

[Question] Yuri Gagarin, the Earth's Spaceman Number One, spent 108 minutes in flight in space. V. Ryumin and V. Lyakhov, Soviet cosmonauts, spent 175 days in space during their recent flight. That was a considerable difference in duration. To what extent has space flight diet changed over the years?

[Answer] During this period there have been no basic changes in the chemical composition of spacemen's rations. Their quantitative and qualitative composition is worked out by scientists for each separate flight on the basis of the results obtained through experiments conducted on the Earth. The assortment and quantity of the foods are largely determined by the duration of the flight. When Yuri Gagarin performed the first space flight in the history of mankind he had a ten day's supply of food aboard his ship. And the food was not very varied. Now it is quite a different matter. The considerably greater duration of space flights naturally calls for a considerable increase in the supply of food and for greater variety. Today the spaceman's rations include over forty types of highly nutritive food.

[Question] What foods precisely?

[Answer] Various kinds of tinned meat, such as entrecotes, roast pork, veal, ham, chicken, assorted meat, liver pate, etc. There is a large choice of soups too, including borshch, sorrel soup, rassolnik (soup with pickled cucumbers), kharcho (highly spiced mutton and rice soup), sauerkraut soup. The spacecraft carries different kinds of bread and confectionery and various fruit juices. Briefly, spacemen's diet is becoming more varied. The food is becoming tastier and more nutritive.

[Question] How is the food preserved aboard space stations?

[Answer] It is rather a complicated affair to preserve the quality of foodstuffs in space. That is why meat is tinned, for instance. The soups, juices and creams are packed in special tubes. Bread, confectionery and fruit, in the form of small cubes which can be placed whole in the mouth, are kept in polymer film.

In the last few years space crew rations have included much larger quantities of dehydrated foods which can be restored in flight with water. This was first done by cosmonauts P. Popovich and Yu. Artyukhin during their flight in the "Salyut-3" space station.

[Question] Would you please tell us something about the cosmonauts' meals, and the time they take the meals?

[Answer] The cosmonauts' health and capacity for work depend largely on their diet in flight, the number of meals per day, distribution of calories, intervals between the meals. It is extremely important for solving problems bearing on space flight diet to find the best answers to these and many other questions. We also bear in mind that meals consisting of tasty and varied foodstuffs are a form of active rest, a source of positive emotions in an exhausting prolonged space flight. Concretely, the cosmonaut receives about 3,350 kilocalories per day. Normally a space crew has four meals a day. Intervals between meals vary from three to five hours.

[Question] In normal life it often takes a man a long time to get used to certain foods. How does it work in space?

[Question] You are right. The human organism must get accustomed to every new type of food. Therefore, the cosmonauts are trained on the ground for this. During their training for flight they receive only the kind of food they will have in space. This makes it possible to test the response of the organism to every dish in the rations and to establish the individual tastes of crew members.

To conclude, I should like to point out that Soviet scientists successfully cope with the rather difficult problems of feeding cosmonauts during space flights of different duration. They are producing better and better rations to keep the crews in good health and enable them to maintain a high capacity for work during the entire flight.

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UDC 611.71:541.68

CHANGES IN BIOMECHANICAL PROPERTIES OF RAT BONES AS A RESULT OF 19-DAY SPACE FLIGHT ABOARD THE ARTIFICIAL EARTH SATELLITE 'COSMOS-936'

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, 1980 (manuscript received 7 May 79) pp 530-537

STUPAKOV, G. P., VOLOZHIN, A. I., ZASYPKIN, V. V. and REMIZOV, S. M., Moscow; paper delivered at Second All-Union Conference on Problems of Biomechanics, Riga, April 1979

[Abstract] A study was made of porosity of bone, strength features of bone, biophysical and mechanical properties of the rat skeleton as related to exposure to space flight factors. Experiments were conducted on SPF rats flown aboard "Cosmos-936" and in ground-based experiments in a mockup of this spacecraft. Femoral and tibial bones were subjected to static buckling and compression tests. Preparation of specimens is described. Regions near the periosteum, endosteum and intermediate zones were submitted to examination, with determination of weight, volume and transverse size. Changes in biometric parameters, density, mineral content of the femur, mechanical properties of the femur and tibia, regression analysis of physical and biomechanical properties of femoral spongiosa were tabulated. Tables 5; references 13: 9 Russian, 4 Western.
[424-10,657]

UDC 612.014

INVESTIGATION OF THE BIOLOGICAL EFFECT OF LUNAR SOIL UPON INTRATRACHEAL INGESTION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian No 6, 1980 (manuscript received 19 Jul 79) pp 947-949

KUSTOV, V. V., BELKIN, V. I., BUGAR', K. P. and ZHAROV, V. V.

[Abstract] Experiments with rats of the Wistar line were used in determining some peculiarities of the biological effect of lunar ground upon intratracheal ingestion. The experiments were made with 30 white male rats of the Wistar line with an initial body mass of 230-250 g. The animals were divided into three

groups of 10 animals each. Rats in group 1 intratracheally ingested 50 mg of a suspension of lunar ground in 1 cm^3 of a 1% starch solution; the animals in group 2 received the same solution with the addition of 50 mg of SiO_2; the 3d group intratracheally received 1 cm^3 of a 1% starch solution. In order to evaluate the biological effect of the lunar soil the general state and behavior of the animals were observed, body mass was registered, the number of erythrocytes and hemoglobin in the peripheral blood were determined and the intensity of elimination of endogenous CO was ascertained. A Rodkey chamber was employed in investigating the latter index. Observation of the animals receiving the lunar soil and SiO_2 indicated that their overall state and behavior during the first two months of the experiment were unchanged. However, in the third month the motor activity of rats in group 2 decreased. The body mass of rats in group 2 increased substantially less than the body mass of the control group and animals receiving lunar soil. By the sixth month, 4 of the 10 rats in group 2 had died. The surviving animals in this group developed symptoms of pulmonary insufficiency; these symptoms were less clearly expressed in rats receiving lunar soil. The hemoglobin content for rats in the second group increased by the sixth month and the number of erythrocytes also increased, whereas in animals of groups 1 and 3 these indices virtually did not differ from the initial levels. The intensity of formation and elimination of endogenous CO in rats of groups 1 and 3 remained virtually identical during the entire observation period. A similar change in this index was observed to the fourth month for animals in the second group, but later the rats in this group eliminated substantially more CO than the animals in the other two groups. Thus, by the sixth month the animals in group 2 had developed silicosis symptoms. The rats receiving lunar soil lagged in growth and their respiration rate increased. However, they exhibited a lesser degree of expression of these symptoms in comparison with animals in group 2 and showed no significant changes in hematological indices and intensity of formation and release of endogenous CO. Figures 2; references 9: 5 Russian, 4 Western.
[34-5303]

UDC 581.18

FLOWERING AND MATURING OF ARABIDOPSIS THALIANA SEEDS UNDER WEIGHTLESSNESS CONDITIONS. EXPERIMENT ABOARD THE 'COSMOS-1129' BIOSATELLITE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 1, 1981
(manuscript received 25 Aug 80) pp 254-256

PARFENOV, G. P. and ABRAMOVA, V. M., Institute of Biomedical Problems

[Abstract] The objective of this study was observation of the generative cycle of Arabidopsis -- from fertilization to the maturing of the seeds. The investigated object was Arabidopsis thaliana, paca Enkheim-1. The plant was in a Plexiglas beaker in moistened soil. During flight illumination was around-the-clock, unidirectional, 8 W/m^{-2}. Two buds unfolded before the plant was placed aboard. After placement aboard, but prior to launching, the plant was in the darkness for two days. The control experiment was under similar conditions,

but the plant was not placed in the darkness. The plant ended its life cycle during the flight, which lasted 18 days. Six mature pods were formed. Pods were not formed from the next eight buds. Comparing the flight time with the duration of individual phases of development of Arabidopsis, it must be assumed that the first two pods were formed from flowers unfolding prior to placement aboard. The next two flowers must have unfolded after placement aboard, but before launching, when the plant was in the darkness. For this reason in the third and fourth pods there were many sterile ovules and embryonal lethals. The last two buds opened under weightlessness conditions and fertilization, embryogenesis and maturing of seeds also occurred in weightlessness. In the flight plant there was a marked change in the number of fertile seeds and an increase in the number of abortive generative formations. There was a high variability of the fertility indices in the pods. Most importantly, the stages of development of plants from meiosis to the formation of mature seeds can transpire normally under weightlessness conditions. The analysis confirmed that weightlessness does not interfere with the course of any stages in plant development. The difficulties in the cultivation of plants under weightlessness conditions are attributable to the lack of satisfactory systems for their life support in the absence of gravity. Tabees 3; references 15: 9 Russian, 6 Western.
[43-5303]

SPACE POLICY AND ADMINISTRATION

COSMONAUT IVANCHENKOV SAYS NEW SPACE STATION WILL PROBABLY BE LAUNCHED NEXT YEAR

Prague SVOBODNE SLOVO in Czech 10 Apr 81 p 6

[Unsigned article: "Space Plans"]

[Summary] At a meeting in Prague on the occasion of the twentieth anniversary of Yuriy Gagarin's flight, Soviet Cosmonaut A. S. Ivanchenkov stated that the "Salyut-6" station "will most likely be replaced by a new orbital station next year."

The article further states that the Czech satellite "Magion", launched in November 1978, is still functioning, but will cease operation by the end of this year. It is also indicated that Czechoslovakia will participate in the Soviet Venus-Halley's Comet mission in 1986.

CSO: 2402/26-P

VERESHCHETIN ON CZECH ROLE IN 'INTERCOSMOS' PROGRAM

Prague RUDE PRAVO in Czech 18 Feb 81 p 4

[Interview with Vladlen Stepanovich Vereshchetin, vice chairman of the Intercosmos Council of the USSR Academy of Sciences, doctor of sciences, by Stanislav Stibor: "Together for Peaceful Space Research"]

> [Text] The colossal development of space research in the Soviet Union is creating conditions for the participation at the highest levels of the scientific communities of the socialist countries in the work of this progressive scientific field. The Intercosmos Program, in which Czechoslovak scientists and experts are playing an important role in the solution of assigned tasks, provides broad possibilities for the participation of the socialist countries in space research and in its utilization for the requirements of their national economies. The Intercosmos Program continues to evolve, and its research activities are more and more rich and demanding. We descussed the results of this work, new objectives, and also the contribution of Czechoslovak science to this joint space research with the vice chairman of the Intercosmos Council of the USSR Academy of Sciences, Vladlen Stepanovich Vereshchetin, doctor of sciences.

[Question] Comrade vice chairman, what has so far been achieved through the cooperation of the socialist countries on the Intercosmos Program?

[Answer] I would like to cite a document -- a proposal by the CPSU Central Committee for the 26th Party Congress -- entitled "The Main Trends in the Economic and Social Development of the USSR for the Years 1981 to 1985 and for the Period Up to 1990." This document also mentions, in addition to many other important tasks, the task of developing space research for the needs of science, technology, and the national economy. Particular emphasis is placed in the importance of utilizing space resources for the resolution of national economic objectives, above all in the development of communications and geological research for the location of new raw materials deposits. The document also cites the objective of further developing and expanding the scientific and technical cooperation of the Soviet Union with other countries, above all with the countries of the socialist community. It is from precisely this viewpoint that I want to comment on what we have achieved and on future possibilities.

The Intercosmos Program occupies an important place in the extensive scientific and technical cooperation of the socialist countries. This is understandable, because the practical contribution of space research today is in the forefront of scientific and technical progress. The Intercosmos Program has achieved significant results in the short period of less than 15 years. At the same time, it must be stated that for practical purposes some of the partners started with nothing. Through the joint efforts of the scientific and production collectives of the socialist countries, instruments and equipment were developed for the Intercosmos series artificial satellites, 21 of which have been launched to date, as well as for 8 Vertikal' geophysical rockets, and for a large number of meteorological rockets and probes. Certain instruments from the countries of the socialist community, among them the CSSR, have already worked, or are working, on spaceships and orbiting stations, on satellites of the Prognoz series, and on automated stations designed to study other bodies of our solar system.

[Question] This has also required, clearly, the development of a scientific potential in individual countries.

[Answer] Of course. At the beginning we took only short steps. We began on the earth and now we are progressing ever farther to the outer reaches of the universe. Our first cooperative efforts consisted of the tracking of artificial earth satellites launched within the framework of the national program of Soviet science. We later moved to the launching of meteorological rockets, then artificial satellites with low orbit paths. Then we began to produce instruments for the Prognoz satellites, which orbit at a distance of 200,000 kilometers from the earth. We are currently planning experiments for farther out in space and we are preparing equipment for studying the planets, above all Venus. This is not simply removing research farther from our planet, but a program which requires the manufacture of complex, modern instruments which require knowledge, sophistication, and the mobilization of scientific and technical resources. This is evidence, among other things, that we have passed the learning years and are now preparing experiments on the level of current worldwide space research. The results of the Intercosmos Program may, without exaggeration, be compared with the results of all contemporary cosmonautics.

The development of research with the aid of automatic instruments is one aspect of our cooperation, and another is linked with a new stage which began in 1976 with an agreement concerning manned space flight. At that time the Soviet Union offered space on the decks of spaceships and orbiting stations to the countries cooperating in the Intercosmos Program, and it was decided that between 1976 and 1983 all member countries would be able to send their own cosmonauts into space and to carry out prepared scientific experiments. As we all know, the space flights under this agreement began in March 1978 with Aleksey Gubarev and Vladimir Remek, and Czechoslovakia became the third country in the world to have a citizen spend time beyond the boundaries of this planet.

Almost 3 years have passed since this first flight and six socialist countries have already sent their citizens into orbit around the earth to carry out experiments. The program is, in other words, being fulfilled and, if I can put it this way, is continuing. I believe that even before the designated period expires we will know the cosmonauts of the two remaining member countries in the Intercosmos Program.

[Question] What is the practical contribution of joint research?

[Answer] A new aspect has begun to make itself markedly evident in the course of the development of our cooperation. Our activities are not directed only at research studies, at the discovery of the basic laws of the universe, even though this is very important, and even though we are also making efforts to penetrate deeper into cosmic space. In addition, today we are more and more directing our research at the resolution of practical problems in the national economy. We are devoting attention to the study of the earth from space, the development of space communications, to increasing the precision of and potential for long-term weather forecasting, the utilization of the findings of space biology and medicine in the health-care field and, last but not least, technical experiments in space which will enable us to obtain new materials for the needs of science and industry.

The Intercosmos Program, then, is developing in three main directions: the first may be defined as the study of the universe itself, the second as the utilization of space resources and techniques for the needs of the national economy, and the third is connected with the development of manned space flight. At the same time, manned flights are not an end in themselves, because the objective is that the cosmonaut himself -- because a machine never replaces the functions and activity of a man -- could carry out experiments in space.

[Question] What is the role of Czechoslovakia in these joint tasks?

[Answer] Czechoslovakia is fulfilling a very active role in all three of the above areas, and we greatly respect the work of your scientific and production collectives. Their contribution is evident from the fact that Czechoslovak instruments have operated on all Intercosmos satellites. Czechoslovakia is also the first country, aside from the Soviet Union, to launch its own satellite within the framework of our program. Magion is, to be sure, small in weight and volume, but as far as I know it has functioned constantly since detaching from Intercosmos-18 satellite in 1978, and this attests to the good work of Czechoslovak experts. One of the significant areas of space research is the utilization of satellites for the needs of geodesy. Laser equipment, manufactured by Czechoslovak scientists is also a great contribution of your country to the development of research in space geodesy.

Recently your scientists have been working on a very interesting project connected with solar research, which is an area in which they have much experience and credentials. Equipment which makes possible the orientation of satellite instruments toward the sun is a technologically very complex system placing high demands on quality and precision of manufacture, and this work is being successfully fulfilled in Czechoslovakia. Your scientists are, at the same time, working jointly with Soviet scientists on an extraordinarily interesting and demanding project, Experiment Intershock, which involves the very detailed study of the properties of interplenetary space and research on so-called shock waves, and which will take place at a distance of 200,000 kilometers from the earth on a Prognoz-type satellite. We are expecting it to take place in 1982. Concurrently, work is progressing in the area of space technology, encompassing design variants of the experiments begun in the flight of Vladimir Remek as well as the development of equipment in which new materials could be obtained in space. The extent of the participation of Czechoslovak scientists is quite extensive, and Czechoslovakia is an outstanding partner for all the members of the Intercosmos Program.

[Question] Articles have appeared recently in the Western press to the effect that the study of the earth and, especially, natural resources from space is not producing the expected results, and that it is inefficient and too costly for most countries. What can you say in response to these views?

[Answer] In our opinion, the study of the earth from space is very useful and belongs among the main trends in space research. It is clear, you see, that the time has come for space research to "pay its debt to people," whether we are dealing with research results for the needs of geology, cartography, forestry, harvest predictions, ocean research or other areas. On the other hand, however, in the past certain optimists have discussed this issue in the press in such a way as to suggest that it would be immediately possible, from a satellite, to identify new raw materials, predict harvests, etc.

All of this work is still in the experimental stage, regardless of the already well-known contributions, and additional great efforts and financial resources will be needed to process rapidly and efficiently the data concerning the earth which we have obtained from space, above all with the help of computers. It will also be necessary to teach geologists, foresters, farmers, oceanographers, and other professional experts to utilize these results in their fields. All of this will require time and it will not be a simple task.

In my view, a main reason for a certain disenchantment is the reality that great hopes are not being fulfilled as fast as expected. At the same time, the overcoming of obstacles and the solution of difficult problems is the natural path of science. It is for this reason that we also concern ourselves with these problems in our national space research program and that the necessity for solving them is emphasized by "The Main Trends in the Economic and Social Development of the USSR," and that we will pay attention to them also in the Intercosmos Program.

It is, however, obvious that it is impossible to answer this question simply. There may exist countries for which some type of study of the earth from space will be inefficient. This, however, may not be generalized. For instance, for certain small countries, geophysical research by satellite does not have to be appropriate. We also know, however, that Czechoslovakia is a small country, and at the same time her experts, who are carrying out cartographic research with the aid of their own airborne resources, currently have a great interest in the utilization of satellites.

In this regard, I would like to state the basic principle of activity in the Intercosmos Program. Each country determines and pursues those tasks and problems which are of scientific interest to it, which are the most appropriate and current from the viewpoint of the needs of its national economy, and in which it has the most experience and the most highly developed scientific and production trends or sectors. This is the strength of our cooperative efforts.

[Interviewer] Thank you for the interview.

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CSO: 2402/53

LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
17 Mar 81	Cosmos-1259	405 km	215 km	90.4 min	70.4
18 Mar 81	Raduga	36,590 km	--	24 hrs 37 min	0.4
		(Near-stationary circular orbit; communications satellite for relay of telephone, telegraph and TV signals in centimeter wave band; international registration index: "Statsionar-2")			
21 Mar 81	Cosmos-1260	458.7 km	435.2 km	93.3 min	65
22 Mar 81	Soyuz-39	Initial parameters not reported			
		(Manned by Flight Commander Dzhanibekov and Cosmonaut-Researcher Gurragcha; docked with "Salyut-6" -- "Soyuz T-4" on 23 March)			
24 Mar 81	Molniya-3	40,655 km	641 km	12 hrs 16 min	62.8
		(Communications satellite for long-distance telephone and telegraph communication and TV broadcasts in the "Orbita" network)			
31 Mar 81	Cosmos-1261	40,170 km	615 km	11 hrs 50 min	62.8
7 Apr 81	Cosmos-1262	418 km	207 km	90.4 min	72.9
9 Apr 81	Cosmos-1263	1,988 km	403 km	109.1 min	83
15 Apr 81	Cosmos-1264	411 km	216 km	90.5 min	70.4
16 Apr 81	Cosmos-1265	317 km	210 km	89.4 min	72.9
21 Apr 81	Cosmos-1266	278 km	259 km	39.65 min	65
25 Apr 81	Cosmos-1267	278 km	200 km	89 min	51.6

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